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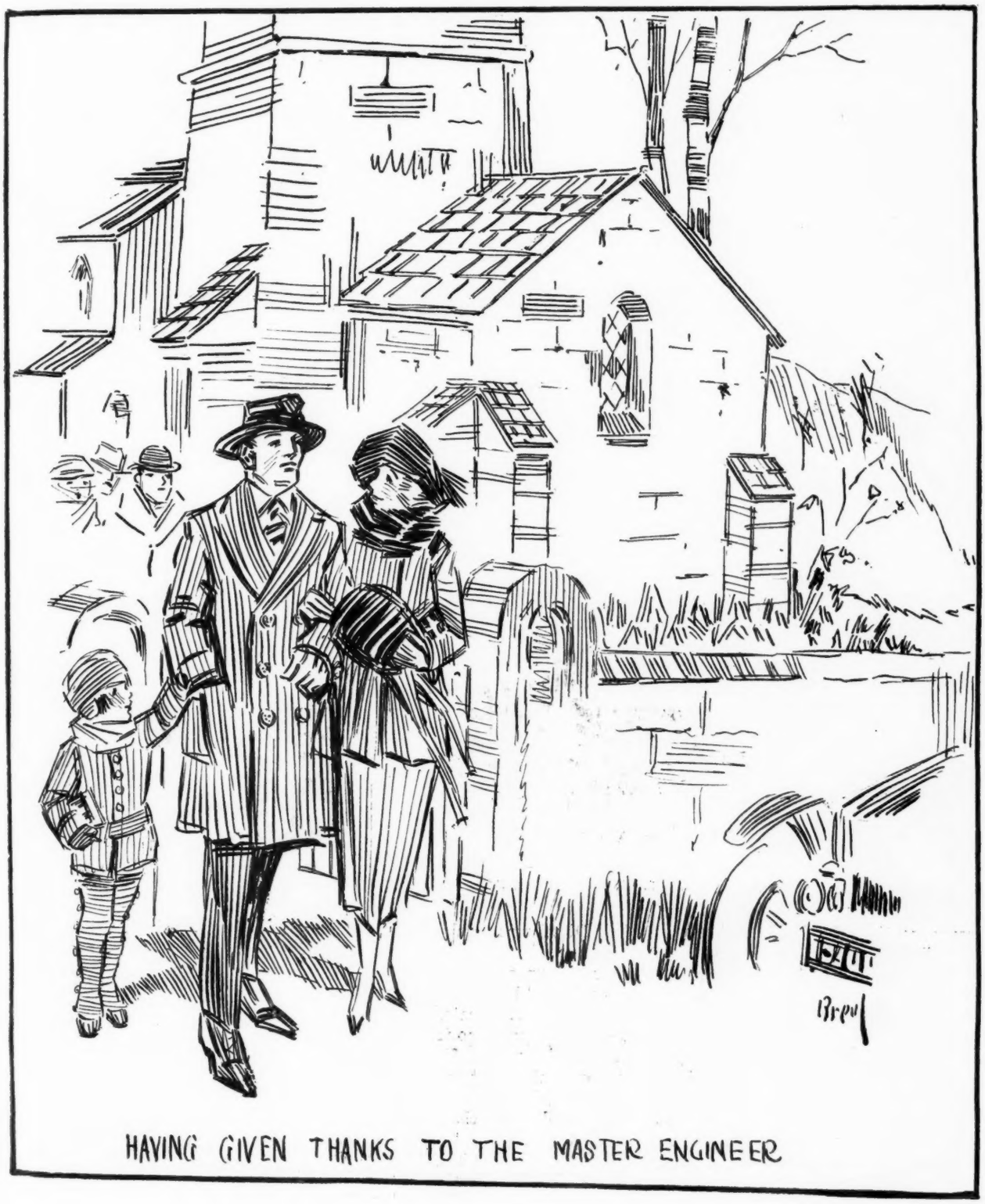


HAVING GIVEN THANKS TO THE MASTER ENGINEER

Diesel Engines in a Modern Flour Mill

IN 1912 the Stanard-Tilton Milling Co. erected a 1,200-barrel flour mill in Dallas, Tex., the mill being one of the most modern in the Southwest. To secure maximum efficiency in the power plant, Diesel oil engines were chosen. Several manufacturers were experimenting with this type of engine, but only one firm, the Busch-Sulzer Co., was in a position to furnish engines backed by a number of years of actual field work. Although the mill required not over 400 brake horsepower, a reserve capacity was deemed desirable; consequently a 450-hp. type A Busch-Sulzer Diesel was installed.

This unit is not a single engine, but is made up of two separate three-cylinder machines each controlled by its individual governor. The two crankshafts are belted to a common drive pulley placed on a stub shaft between the two engines. The flywheel effect is obtained from two flywheels, one being mounted on each engine shaft. The crank throws are so set that the cylinders of the two engines fire by pairs; the unit is then a double three-cylinder engine. It has been found that the regulation is better than when the cylinders are set to fire in rotation as a six-cylinder single engine. On the other hand the latter arrangement gives a greater brake horsepower. The two Busch-Sulzer Diesels appear in Fig. 1. The rope drive from the driving pulley to the mill is shown to the right of the engines; the rope is practically horizontal and has a horizontal tension carriage.

To give light and power to the grain elevator, a 50-kva. generator is driven off the flywheel of the rear engine in Fig. 1. The air compressor for the unit is belt-driven from the rear engine, the drive appearing in Fig. 2, which shows the switchboard as well. The exhaust lines run horizontally through the building wall with vertical exhaust pipes outside. From an examination of Fig. 1 it will be noticed that the exhaust pots are provided with a water drip. It is usual to find the pots eaten out by the sulphur and water, but in this plant no trouble of this kind has occurred.

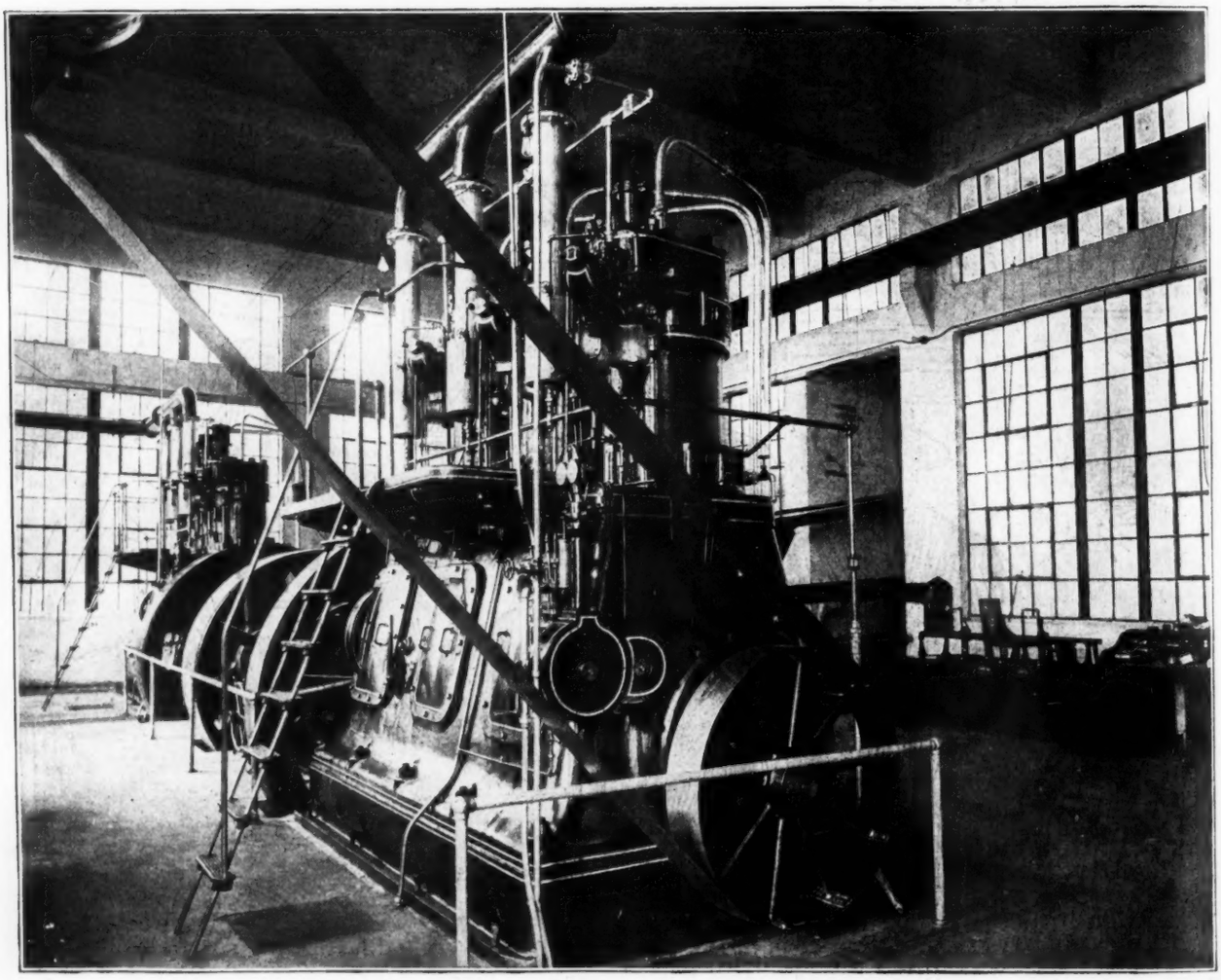


FIG. 1. 450-HP. BUSCH-SULZER TYPE "A" DIESELS

The cooling water is carried in a rectangular overhead tank just outside the building. The cooling water from the engines flows into a sump, is picked up and discharged over the cooling racks in the overhead tank.

The water flows through the engines by gravity. The circulating pump and motor, both of Allis-Chalmers make, appear in Fig. 3, which also shows the heating boiler and auxiliary engine.

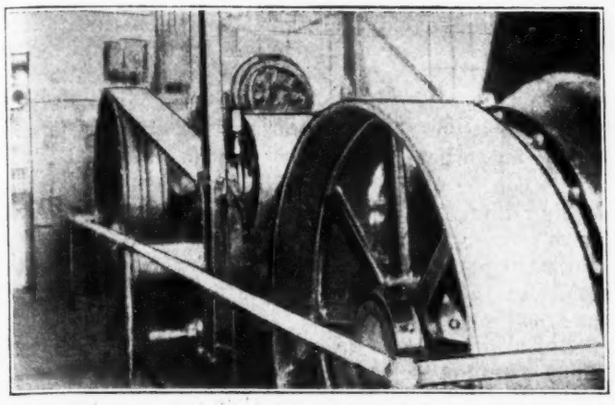


FIG. 2. TYPE "A" AIR-COMPRESSOR DRIVE

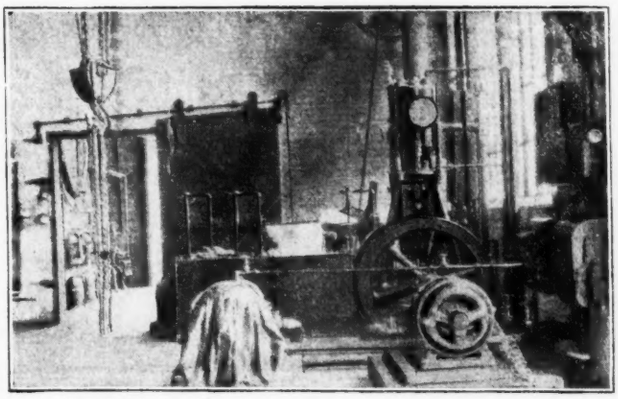


FIG. 3. CIRCULATING-WATER PUMPS

In 1919 the milling company erected a duplicate mill adjoining the one under discussion. This mill is completely equipped with roller bearings, thereby reducing the friction loss by 50 per cent. To drive this mill a 585-hp. Fulton-Tosi Diesel was purchased. This unit is shown in Fig. 4 and is set behind the two type A engines.

The new engine has four working cylinders; the cylinder liners are pressed into A-frames. A 192-kva. G. E. three phase 60 cycle generator is direct-connected to the extended shaft and has a built-in exciter. The engine-shaft extension also carries a friction clutch and rope-drive pulley. The engine is always started with the clutch disengaged. To prevent damage to the rope, a Dodge electric telltale operates a solenoid, which in turn allows a weight to unclutch the pulley.

At present the new mill is not in operation and the Fulton engine is used to drive the old mill, while the type A engines are held in reserve.

This Diesel station is a revelation to a steam engineer accustomed to a plant where the available space is filled with machinery such as pumps, fans, condensers, etc. The oil engine, with the exception of the circulating pump, is self-contained. The engine room, as a

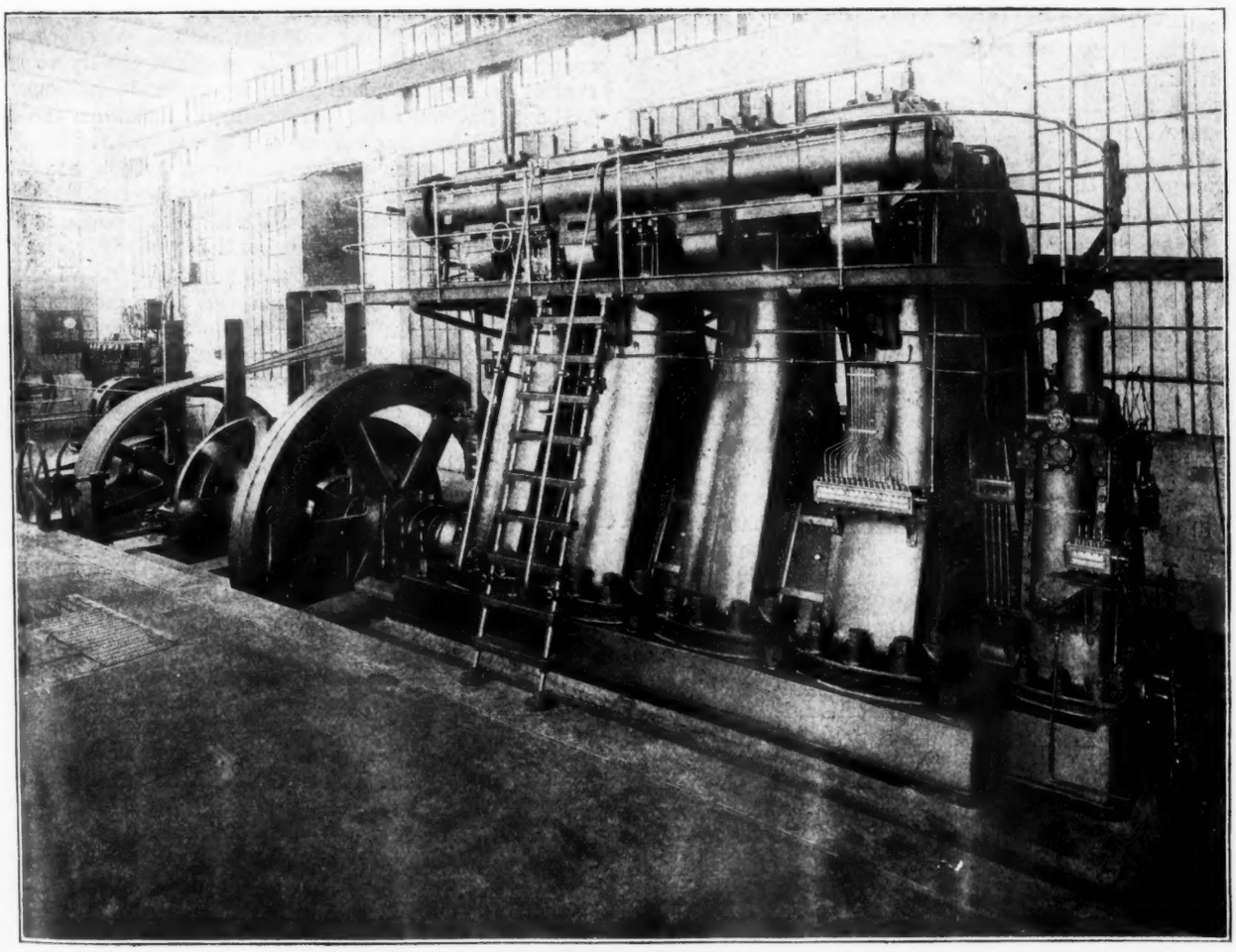


FIG. 4. 585-HP. FULTON-TOSI DIESEL

result, is light and airy, with every inducement to the operators to keep the place clean.

The Stanard-Tilton plant has had an exceptionally fine history. No serious accidents or breakdowns have occurred. This, in a great measure, is due to the high class of engineers that have operated the plant since it

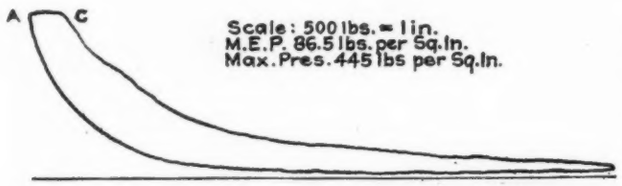


FIG. 5. FULTON-TOSI INDICATOR DIAGRAM

first started. It is one of the few plants where indicator cards are taken regularly. Fig. 5 is a diagram from the Fulton engine while carrying approximately full load.

Chain-Grate Stoker Operation

BY W. M. MCNIELL

The selection and preparation of the coal is of first importance in the successful and economical operation of a chain-grate stoker. With the fuel situation as it is at present, the engineer has very little choice in the kind of coal he burns, as he is glad to get anything that even resembles coal, but he can at least see that the fuel is properly prepared before it is passed to the stoker. When it can be obtained, a non-caking bituminous coal should be used. It should contain as small a percentage of ash as possible and the fusing temperature of the ash should be high in order to eliminate the clinker nuisance as far as possible. Of course the greater the number of heat units the coal contains the more desirable it is, provided that the heat units are available for producing steam. If the coal contains a large percentage of ash and the ash fuses at a low temperature, forming clinkers, thus preventing a sufficient amount of air passing through the fuel bed and retarding combustion, even though the coal contains a great number of heat units, only a small percentage may be available for the production of steam, and it would not be as desirable as a fuel that contained less heat units, but more of which were available for useful work.

As stated at the outset, a non-caking bituminous coal will give better results on a chain grate than a coking coal. The latter will, of course, run together, forming one solid mass of coked coal through which it is next to impossible to get sufficient air to secure complete combustion. There are a great many other reasons why a non-caking coal is more desirable than a coking coal, which will not be discussed in this article.

Next in importance to the selection is the preparation of the fuel. In plants not prepared to crush the coal it is best to secure a good grade of screenings of as near uniform sizes as possible. It will be found that these give fairly satisfactory results on this type of stoker. In supplying screenings from an overhead bunker through a spout to the hopper of the stoker, the lumps and the fine coal have a tendency to separate, the larger sizes coming out on each side of the hopper and the fines accumulating in the center of the hopper. This of course distributes the larger sizes on each side of the chain, while the fine coal will be in the center. The large sizes along each side will burn off first, leaving the grate bare and allowing excess air to enter the furnace at these points, with insufficient air entering through the center of the grate, where the coal is not burned and where it is most needed.

This can be overcome by providing means for thoroughly mixing the coal as it is delivered to the stoker. Large lumps of coal or other objects should never be allowed to reach the stoker hopper, as they are sure to break out the brick in the grate and give trouble in numerous ways. I was once forced to use some run-of-mine coal on a chain grate very much to my sorrow. The coal was broken up as much as was possible with hammers, but the large chunks soon ruined a perfectly good grate and forced the plant out of service.

In the larger-sized plants crushers are usually installed for reducing the coal to the proper dimensions, and such plants may purchase a run-of-mine or even the domestic sizes, if they are not too expensive, and prepare them for use on the chain grate. These plants have an advantage over the smaller ones which are not fortunate enough to be equipped with coal-crushers, as they may purchase the coal that is best adapted to their needs.

It is also essential to keep the ignition arches and other brickwork in connection with the stoker in good condition. Given the very best of coal, well adapted to the stoker and the conditions under which the coal is to be used, and assuming that it has been properly prepared, results cannot be expected unless the stoker and all its accessories are kept in the very best of condition. The arch should be watched closely to see that it is kept in good order, especially if it happens to be a flat suspended arch, for as soon as one or two bricks have spalled off to a great extent, the fire will begin to reach the supporting ironwork and will cause it to fail in a very short time. Even if the arch does not fail entirely, it functions very poorly in its duties toward promoting combustion.

The stoker should be watched closely also, as a broken link means a hole in the fuel bed for excess air to enter, as well as an increased amount of unburned coal under the grate to be raked out and returned to the hopper. Frequently the coal under the grate is allowed to take fire and burn for a considerable time. This overheats the chain as well as other parts of the stoker and will surely cause serious trouble. It should never be permitted.

The efficiency of a chain-grate stoker will, of course, depend to a great extent on the design of the stoker and the manner in which it is installed. If an engineer has to accept the stoker his employer feels like furnishing him, he has nothing to say about the design, but he can have something to say about the way in which it is installed. He should see that observation holes are properly placed in the setting, so that the condition of the fires and the furnace may be readily observed. He should have clean-out doors so located that clinkers and other objects may be easily removed from the furnace. In case of extremely wide furnaces, a clean-out door as well as observation holes should be placed on each side of the setting.

The stoker should be set so that it may be rolled out of the setting for examination and repairs. In a certain plant, a chain-grate stoker was installed under a Stirling boiler. The stoker was fifteen feet in length,

but the distance from the front end was only six feet from the boiler-room wall, making it impossible to draw the stoker from under the boiler. Whenever repairs were to be made it was necessary to go inside the furnace to do the work, which of course made it inconvenient. This same setting has a clean-out door on each side, but the boiler-room wall is only three feet from one of the doors on one side and a set of boiler feed pumps are directly in front of the other door. The doors in any setting should be so arranged that the fireman may hook the clinkers out of his fires, for he will surely have to keep them out if he would get economical results.

If the fuel bed is carried too thick and the chain is driven too fast, the fuel will have a tendency to pile up at the water back or bridge wall. When this happens, either the fuel bed must be thinned down or the speed of the chain slowed up. At times it is well to compromise by thinning the fuel bed a small amount and at the same time slowing down the speed of the chain.

Under ordinary conditions the proper speed for a chain is about eight inches per minute. With very light loads it may be less and with heavy loads a little more. However, it is better to thicken or thin the fuel bed to suit the conditions than to change the speed very much.

The Philo Multigage

The Philo Multigage is the result of a demand for an instrument that will tell at a glance a complete story of the existing draft and pressure conditions. It is a combination draft and pressure indicator, and it gives either reading or both simultaneously.

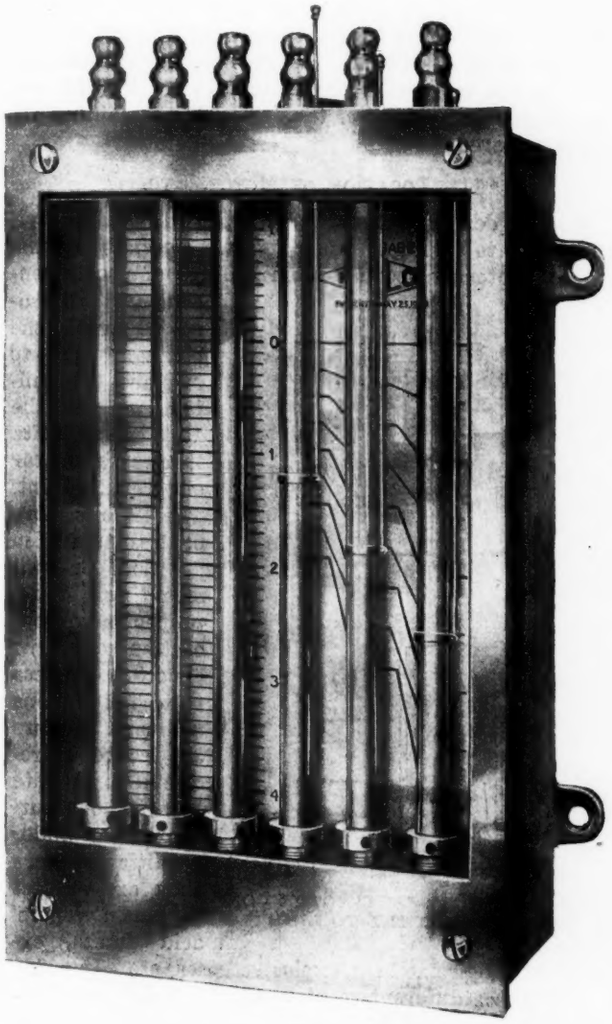
The gage is a nickel-plated brass casting and weighs approximately 10 lb. The six tubes into which the liquid flows connect with a common storage tank, which is filled to the zero mark on the scale with special gage oil having a specific gravity of 0.89. The tubes are in such proximity that a careful comparison of each reading with any other may be obtained. With conditions running along normally, the height of the liquid in the various tubes forms a certain curve. Any variation in the characteristic of this curve, caused by too heavy fire on some point of the grate or by blowholes, will tell the fireman what he should do and where he should do it, to adjust conditions.

There is nothing mechanical to get out of order. Gravity is the sole adjuster in this instrument. To insure a tight oil seal at the bottom of each tube, a stuffing gland and oilproof packing are used.

This gage, which is manufactured by the Schumacher-Santry Co., 141 Milk St., Boston, Mass., is designed not only to indicate graphically the pressure conditions at various points in the blast system, but also to instruct and guide the engineer as to the proper relative pressures at the different indicated points in the system.

The gate is made in two sizes. Type C, indicating the draft up to 1.3 in. and pressure up to 4 in., is supplied with a special proportional chart for use in connection with the Coxe type of traveling-grate stoker. This chart consists of a series of zigzag lines each showing the comparative air pressures desirable under a given set of operating conditions in the first, second and third air compartments, when burning anthracite buckwheat. For example, the outside tube of the gage is connected to the first compartment. If this shows, say, 3 in. pressure, the liquid will stand at the horizontal part of one of the zigzag lines 3 in. below 0. By following this same zigzag line upward and over to the second tube, it will be seen that the next horizontal part of this line is about 2.1 in. below 0, at or near which point the liquid should stand. Farther upward and over on this same line to the other tubes, a pressure of 1.4 in. will be indicated.

When other fuel is used on this stoker or when the gage itself is applied to other kinds of stokers, the adjustable sliding clips shown in the cut may be used in place of the chart.



PHILO SIX-TUBE MULTIGAGE

The Type E gage indicates a draft up to 1.3 in. and a pressure up to 6 in., and is for use in connection with other kinds of mechanical stokers.

A Correction

In the editorial, "Power Development of the Future," on page 753 Lazarovich-Hrebelianovich is referred to as being a "well-known Czecho-Slovakian engineer and economist." Instead, he is of Serbian nationality, and is well known as such in engineering, banking and diplomatic circles in this country.

Application of Induction Motors—III

Location of Motors — Connections Between the Motor and Driven Machines — Nature of Load and Power Demand—Underwriters' Requirements for Motor and Controllers—Protection of Motors—Other Types of Motors.

By FRASER JEFFREY
Electrical Engineer, Allis-Chalmers Manufacturing Company

IN THE first article of this series, published in the issue of Oct. 26, sixteen points to be considered in application of induction motors were outlined and five of them discussed. In the second installment, Nov. 9, five more of these features were treated and in this, the last article of the series, the remaining six are considered.

11. Location of Motor, Etc.

A great deal of trouble with motors has been experienced due to improper foundations. Epecially is this true of motors suspended from ceilings of poorly constructed buildings, when the ceilings tend to sag and the pulling up of the foundation bolts throws the motor out of alignment. The same is more or less true also for floor or wall mounting, and proper motor operation cannot be expected unless rigid foundations are used. Motors are frequently required to operate indoors or outdoors and under conditions where they are subject to steam vapors, acid fumes, extreme dust, extreme heat, explosive gases, etc. In order to meet these different requirements, the American Institute of Electrical Engineers has realized that oftentimes standard apparatus is unsuited to meet special conditions and has therefore recognized the following types of machines: (1) Open; (2) protected; (3) semi-inclosed; (4) inclosed; (5) separately ventilated; (6) water-cooled; (7) self-ventilated; (8) drip-proof; (9) moisture-resisting; (10) submersible; (11) explosion-proof; (12) explosion-proof slip-ring inclosure.

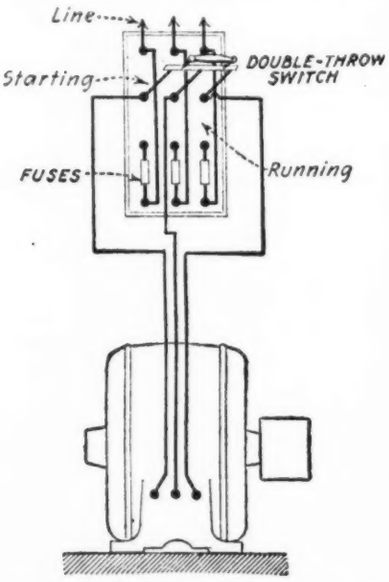


FIG. 1. SQUIRREL-CAGE MOTOR CONNECTED DIRECTLY TO LINE

Standard commercial machines may be classified under 1, 7 and 9, and are defined as follows:

1. An "open" machine is of either the pedestal-bearing or end-bracket type where there is no restriction to ventilation other than that required by good mechanical construction.

7. A "self-ventilated" machine differs from a separately ventilated machine only in having its ventilating air circulated by a fan, blower or centrifugal device integral with the machine.

9. A "moisture-resisting" machine is one in which all parts are treated with moisture-resisting material. Such a machine shall be capable of operating continuously or intermittently in a very humid atmosphere such as in mines, evaporating rooms, etc.

As altitude directly affects temperature, it is recommended by the American Institute of Electrical Engineers that for machines intended for operation in altitudes higher than 3,300 ft. above sea level, the permissible rise in temperature at sea level shall be reduced by 1 per cent for each 330 ft. by which the altitude exceeds 3,300 ft.

It is therefore seen that due consideration must be given the location and conditions under which motors have to operate, otherwise correct applications cannot intelligently be made.

12. Will the Motor be Direct-connected or Belted, Etc.?

As has already been indicated (in the second article, Nov. 9 issue) it is desirable for motors direct-connected to their loads to have some form of flexible coupling between the two members. There are, of course, exceptions such as may be found in small units or vertical outfits, but in general it is advisable that the drive be so arranged that any chance for vibration, thrusts, misalignments, etc., of the driven load be contained therein and not be transmitted to the motor. Incorrect belting arrangements are often the cause of considerable bearing trouble and are seldom given the necessary thought to insure good operation. Belt speeds to insure the best results should not exceed from 3,700 to 4,500 ft. per min. and in the most extreme cases the limit should not exceed 5,500 to 5,700 ft. per minute.

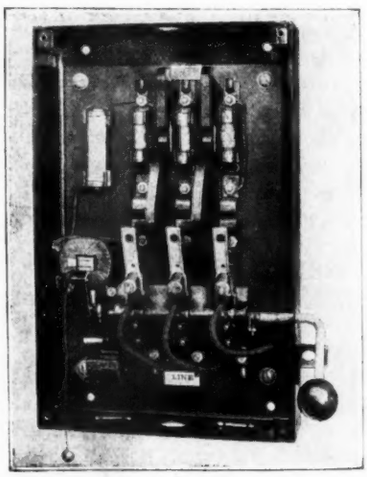


FIG. 2. A.-C. FUSED STARTER, COVER REMOVED

It is desirable that the angle of the belt with the floor should not exceed 45 deg. and the direction of the belt motion should always be such that the loose side or sag is on top. This increases the arc of contact, which in correct practice probably averages in the neighborhood of 180 degrees.

Vertical belt drives should be avoided wherever possible inasmuch as the belt must be kept very tight to do the work. In addition to this, it should be noted

that in cases where the belt drive is downward, such as in ceiling-suspended motors driving to the floor, the whole weight of the belt is a factor contributing to increasing the pressure on the motor bearings.

For standard horizontal drives the belt centers should be such as to allow a slight sag to the belt when in motion, and for the usual small drive for belts not wider than 4 in. 10 to 15 ft. is the lowest limit rec-

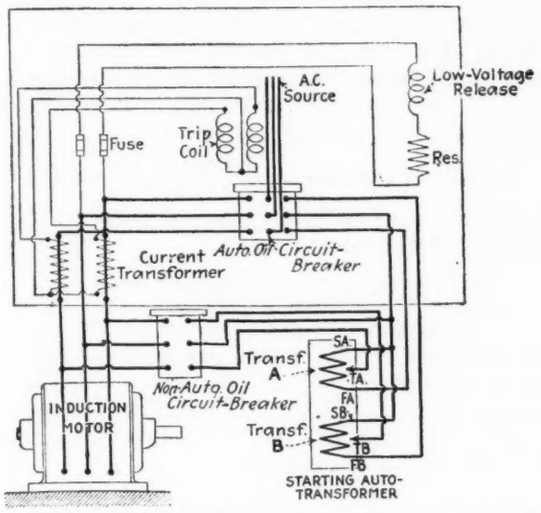


FIG. 3. CONTROL CONNECTIONS FOR LARGE SQUIRREL-CAGE MOTORS

ommended. For larger drives 30 to 45 ft. or even more is the limit used, depending on the power transmitted, the pulley sizes, etc.

As the pressure on the bearing on the pulley end of the motor is directly dependent on the belt pull, which in turn is dependent on the belt speed set by the pulley diameter, any change to pulley diameters smaller than given as standard or a minimum, by the motor manufacturer, reduces the factor of safety on the bearing beyond that deemed safe for good operation.

13. If Power Is To Be Bought, Will the Power Demand Meet the Local Power Company's Requirements?

In cases where power is to be bought, the nature of the load and the power demand is not often fully understood. For instance, many power companies, in addition to a flat rate, have a maximum-peak rate and also penalize for power factors lower than 80 or 85 per cent. Frequently, the nature of the load is such that a flywheel can be used to reduce the peaks and in this manner insure lower power bills. Again, high-speed motors, having better power-factor characteristics than slow-speed motors, may be advantageously used by a change in the method of drive. This might involve higher first costs which will be more than offset by savings ultimately made in the cost of power. Furthermore, some power companies might be able to carry a certain true power load at 80 per cent to 85 per cent power factor, but be unable to carry it at 65 per cent to 70 per cent power factor owing to the limitations of their generating equipment. While this latter applies more to units of fairly large capacity, still a large number of smaller units will produce the same effects. It simply goes to show that due consideration must be given the power apparatus back of the motors.

14. Will the Motors and Control Meet the Local Underwriters' Requirements?

All electrical apparatus must be installed in accordance with the rules and requirements of the local underwriters as well as the National Board of Fire Underwriters or any other board holding jurisdiction in the particular district in which the apparatus is to be installed. Unfortunately, districts and states are governed by rules differing from other districts and states. A large difference in requirements is apparent, from a perusal of the different rules, for motor-driven fire-pump apparatus, both motors and control, and, while differing widely for different districts, is usually covered by special regulations made by the particular city or town in which the installation is to be made, in addition to the requirements of the National Fire Protection Association. Apparatus for use in flour mills and grain elevators is generally governed by the Millers mutual fire insurance companies, so that standard or commercial machines frequently cannot be used for special and particular applications. A study of all the underwriters' requirements for the districts in which

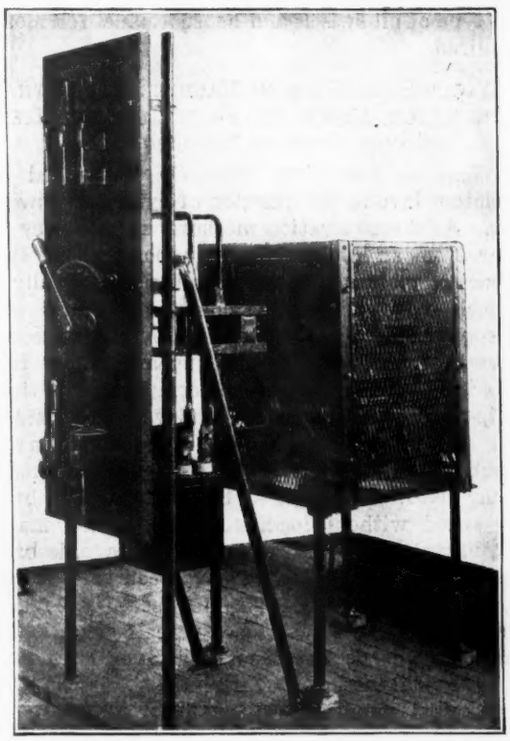


FIG. 4. STARTING PANEL WITH FACEPLATE STARTER FOR SLIP-RING MOTORS

the apparatus will ultimately be installed may reveal the fact that special motor construction, pump construction, and even control construction is sometimes involved.

15. Will the Motors Be Supplied with Adequate Protection Such as Overload, Low-voltage and the Necessary Interlocking Devices?

All motors should be protected against overload. For small squirrel-cage motors, 5 hp. and under, a fuse, as in Figs. 1 and 2, is often deemed sufficient, while for the larger motors a relay, Fig. 3, used in combination with a no-voltage release, is to be advocated. The method shown in Figs. 1 and 2 for starting the

small motors provides protection for the running condition only and makes no provision for protection during the starting period. Full overload protection during starting and running and no-voltage release may also be had by the use of starters made especially for these small types of machines, but their first cost is naturally greater than the simple knife switch and fuses.

For slip-ring motors the foregoing protection is also needed, but some form of interlock, either electrical or mechanical, and between the primary switch and the secondary starter and control, is recommended, especially for motors in capacities of 50 hp. and above. This prevents throwing the stator windings across the line with all secondary resistance out of the circuit.

With multiple-switch starters the no-voltage release takes the place of the interlock, but with the drum-type starter auxiliary contacts on the drum, acting in conjunction with the relay, prevent the reclosing of the primary switch until the starter is brought to the off position. A mechanical lock functioning in the same manner and used in connection with primary oilswitches and face-plate starters is shown by Fig. 4. The use of this type of lock is limited, however, to the back of board type of oil switch and hence a panel for mounting is required.

16. Would Some Type of Machine Other than an Induction Motor Be Preferable to Meet the Existing Conditions?

Applications requiring extremely slow-speed induction motors involve the question of extremely low power factor. As a conservation measure, an efficiency measure, or from an engineering standpoint alone, the use of induction motors in these cases is not especially good. For such drives the synchronous motor has of late been supplanting the induction motor at practically no greater first cost. As the starting and pull-in torques of this type of machine are not comparable to those of the slip-ring induction motor, and where the starting-torque requirements are large, a form of magnetic clutch between the motor and its load has been successfully used. This allows the motor to be brought up to speed without load, after which the magnetic clutch, having a certain element of slippage, is brought into play. Such installations have been used in rubber mills, flour mills, cement mills, etc. (see Fig. 5).

A study of details sometimes reveals conditions that at first thought do not seem logical or even correct. Take, for instance, a centrifugal pump that has to operate against a varying head and deliver a constant quantity of water. It does not seem logical and correct to say that more efficient operation can be had under such conditions by the use of a slip-ring type induction motor running at reduced speed by means of energy dissipated in an external resistance unit than could be obtained by the use of a squirrel-cage type induction motor driving the pump at constant speed, the variations in head being taken care of by throttling the discharge line. But such is the case provided a reasonable amount of running has to be done at the lower speed and the volume of water delivered has to remain constant.

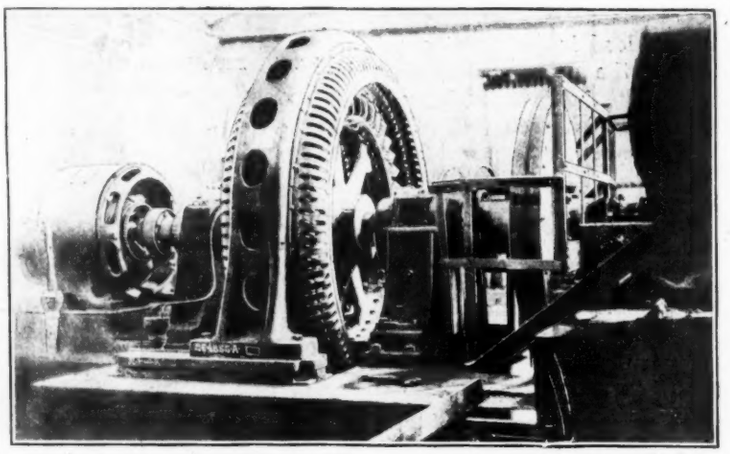


FIG. 5. SYNCHRONOUS MOTOR DRIVING A CEMENT-GRINDING MILL THROUGH A MAGNETIC CLUTCH

Assume the condition where the slip-ring motor has to run at a reduced speed all the time. Suppose that the pump requires a 250-hp. motor which operates at a speed of 1,760 r.p.m. when the full amount of water is being delivered. If the full-load efficiency of the motor equals 92 per cent and the full-load power factor equals 92 per cent, then if the pump is run at 1,490 r.p.m., the power required will be

$$h.p.\ output\ of\ motor = \frac{(1{,}490)^3 \times 250}{(1{,}760)^3} = 152.$$

and the efficiency will, for practical purposes, fall off directly as the speed and be

$$\frac{1{,}490}{1{,}760} \times 92 = 78\ per\ cent\ at\ 1490\ r.p.m.$$

(*Assuming a flat efficiency curve*)

At this load of 152 hp. the power factor will drop from 92 per cent to 90 per cent. (This would be considerably lower if a slow-speed motor were being considered.) The input and the basis on which the cost of power will be based is therefore

$$Hp.\ input\ of\ motor = \frac{152}{0.78} = 195\ horsepower.$$

Consider now the case of the constant-speed squirrel-cage-type induction motor operating at the same full-load speed of 1,760 r.p.m. as the slip-ring motor. If the full-load efficiency is 92 per cent and the full-load power factor is 93 per cent, then when the pump is delivering the same amount of water (by throttling) as when driven by the slip-ring motor at 1,490 r.p.m., the load on the motor remains constant and the efficiency and power factor do not alter. On this basis the power input to the motor will be

$$hp.\ input\ of\ motor = \frac{250}{0.92} = 272.$$

which, when compared to the 195-hp. input, shows that a much larger expenditure for power is required in the latter case if power is bought on the basis of so much per kilowatt-hour. It has the advantage, however, of a better operating power factor.

The importance of correct application is being realized more and more every day. It is becoming more or less of a science, and men are beginning to make a study of it and to devote more time to it. The old hit-or-miss method is being done away with because of the fact that it is recognized as being not only wasteful, but also inefficient. Looking at the proposition broadly, it can be asserted that correct application is a means ultimately conserving the natural resources of the country.

Piling Storage Coal to Prevent Fire

By W. D. LANGTRY
President Commercial Testing and Engineering Co., Chicago, Ill.

In the storage of coal more care must be given to selection as to origin and size, the choosing of a suitable place, avoidance of breakage in unloading, segregation of different sizes, outside sources of heat and the mixing of combustible matter with the coal. Do not pyramid the coal, but pile in layers and as shallow as the available space will permit.

THE storing of coal is a national necessity. Storing during the summer months will act more or less as a governor, tending to even up the load factor on the mines. If the railroads of the country can be relieved of at least a part of the coal hauling during the winter months, it will help them also. The consumer will have been materially benefited as well as the railroads and a more even running time given the mines. It is entirely possible and likely that when "a normal" is reached in the coal industry, there will be a summer and winter price similar to the hard-coal arrangement, where there is a drop in price April 1 and then a raise of ten cents per ton each month to Sept. 1. If thirty to fifty cents a ton can be saved, it is an item well worth considering. The railroads have realized this and have stored thousands and thousands of tons annually when coal could be bought cheapest and transported the easiest. They have been great offenders in the past when it came to successfully storing coal, but they have realized the importance of storing and, by studying the causes of fires, are far more successful than heretofore.

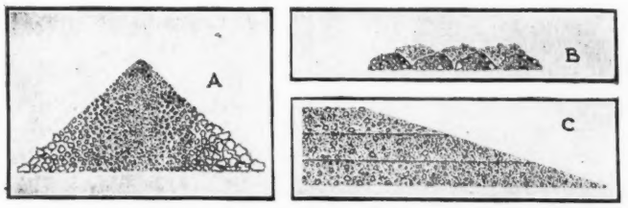


FIG. 1. METHODS OF PILING COAL. A, INCORRECT METHOD; B AND C, CORRECT METHODS

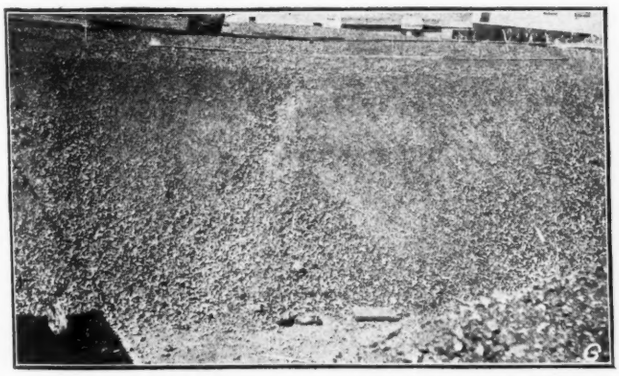


FIG. 2. PILE FORMED BY CONTINUOUS DUMPING FROM TOP EDGE

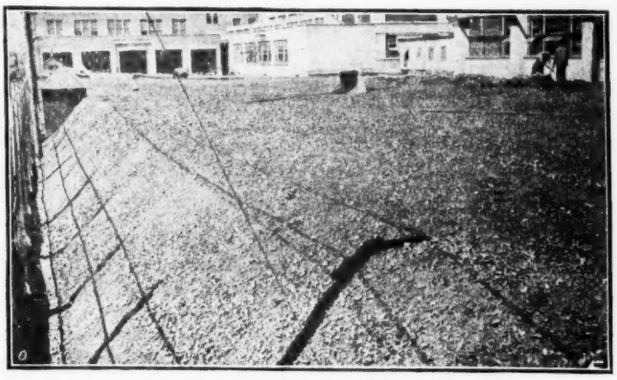


FIG. 3. PILE FORMED BY LAYER METHOD GAVE NO TROUBLE

When the average plant buys coal for storage, the management tells the engineer it is on the way and to see that it is unloaded. Coal will never be stored successfully in this way. Some one person should be made responsible. There are some general principles that hold true for every storage pile. No matter where the coal comes from, no oily waste, rags, paper, shavings, nor in fact anything foreign of a combustible nature, should be left under or in the coal.

Some coals are more susceptible to spontaneous combustion than others. If the purchaser has his choice, naturally the kind best suited for storing should be purchased. There are few bituminous coals that have not at some time given trouble, and again some that have the worst reputations for firing have been stored successfully.

It is known that coal will absorb heat very easily. It is for this reason that storing of coal in summer is more hazardous than during the winter, so that far more care and attention should be exercised. In fact, summer storage should be surrounded with all known precautions. Steel railroad cars that were saturated with heat have been known to transmit the heat to the coal. This may be a source of trouble unless the coal is given a chance to cool off. Likewise, hot steam pipes, the top of sewer manholes or hot furnace walls, when in close proximity to the coal, may be the means of adding heat and accelerating the process of combustion.

The surface of coal is oxidized by the air. This being the case, it would seem judicious to go on the principle of "locking out" the air, as it were, from a pile. This is accomplished when coal is stored under water—the most successful system of storage known.

Mine-run coal has all the different sizes that come from the mine. It is the one kind of coal in which the segregation of the different sizes is most likely to take place if care is not taken when it is unloaded. If clamshell after clamshell, or shovelful after shovelful of this coal are dropped on top of each other, it will be found that the lump coal rolls to the bottom and to the outside of the pile. This causes the fine to pyramid in the center. As the large lumps will not lie close together, it is possible for the air to pass on through to the interior

of the pile, where the finer coal is located with more of its surface exposed to the oxidizing element.

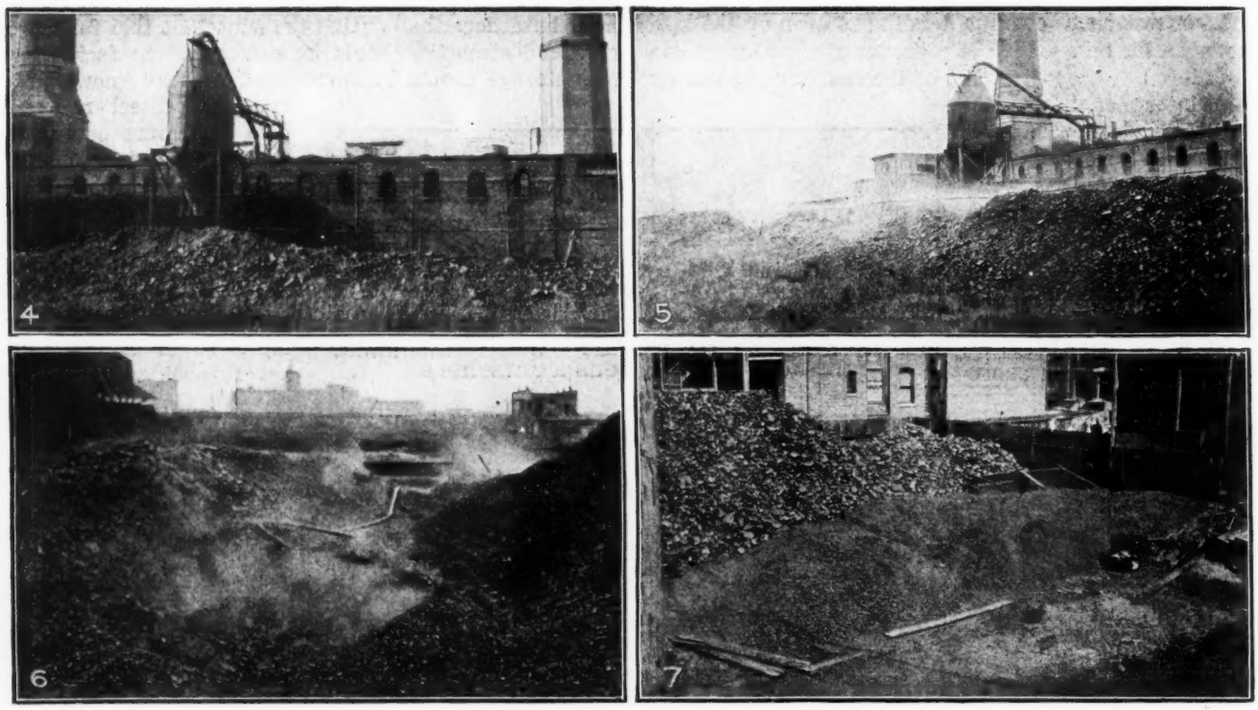
Experience seems to indicate that if this segregation is not permitted to take place and the coal piled in layers and not allowed to pyramid, the chances for spontaneous combustion are reduced to a minimum provided some other outside agent is not contributary to the heating of the coal. Pile *A* in Fig. 1, gives an idea of the pyramiding effect from clamshell unloading. Pile *B* to the right shows individual dumps side by side. Then if it is possible to level off the coal so that each layer is approximately two feet thick, the fine will fill in between the lumps and act as a seal; the pile thus formed appears at *C*.

A striking example was photographed at a plant in Chicago. Screenings from two different mines were delivered mixed for storage. As shown in Fig. 2, the coal was unloaded onto the pile by wheelbarrows dumping one load on top of another until the pile reached the height shown in the picture. It was then extended back from the railroad switch by continually dumping the coal at the top edge, this causing it to roll to the bottom. The coarser coal will be seen at the bottom and in streaks up the sides. This pile was placed in one part of the yard and gave an immense amount of trouble from spontaneous combustion and had to be moved and used up.

The coal in Fig. 3 from the same mines was unloaded by dumping one wheelbarrow alongside of another and leveling off so that a layer of coal was formed on the entire available space for the storage pile. The first layer put down was about two feet deep. The second layer was put on top of the first by wheeling over it. This had the effect of packing down the first layer, thus helping to keep out the air. In this way a pile eight to nine feet deep was built up layer by layer. The more or less even distribution of the fine and large pieces throughout the pile will be seen in the picture. This coal gave no trouble whatever from spontaneous combustion. At a plant in Indianapolis the same plan was adopted and the coal was carried through for two years, until it was necessary to use it during the strike.

To many plants placing coal in storage the depth of the pile seems to be a perplexing question. A good plan to follow is to go on the principle of piling the coal as shallow as possible and in layers over the entire space that is available for this purpose. The item of expense always enters into this method both for unloading and reclaiming. Safety first is a good motto to follow.

Figs. 4. and 5 show a pile of coal over the top of which has been placed a sprinkler system. The coal in this pile started to heat and the engineer knew if he could get enough water to the seat of the fire it would be quenched. Fig. 5 shows the spray in action. The water was sprinkled 24 hours a day for a stretch of about thirty consecutive days. This method successfully kept the heating under control and finally cooled off the pile so that no more spraying was necessary.



FIGS. 4 TO 7. FIRE PREVENTIVE METHODS

Fig. 4—Sprinkler line on top of mine run. Fig. 5—Sprinkler line in action. Fig. 6—Unsuccessful attempt at "cooling off" with line of hose. Fig. 7—Hot coal that was cooled off by repiling in layers.

It is a well-known fact that unless enough water is used, it is poor policy to try this method for cooling-off purposes. Where a hose and nozzle are used, it will be found more effective to bury the nozzle in the pile, directing the stream toward the seat of trouble. More harm than good takes place unless the pile is thoroughly soaked and completely cooled off. Unless the stream actually reaches the hot spot, it may have the tendency to temporarily seal up the heat and cause the fire to break out afresh a little later on.

It is almost impossible to combat successfully a fire that has spread all over a pile with a line of hose, as in Fig. 6. A better way is to move it. In some cases where coal has heated, it is good policy to burn it up at once, as it saves rehandling and any further danger

from fire. When storing coal, it would be well to keep in mind the following suggestions:

1. Some one person should be appointed to supervise the storage of coal and be held responsible for its success.
2. A suitable place for storage should be selected.
3. The coal should be carefully selected as to origin and size.
4. The breakage in unloading should be kept at a minimum.
5. Segregation of the different sizes should be avoided.
6. The coal should not be piled where outside sources could be contributing agents for transmission of heat.
7. The principle of "packing" the coal so as to lock out the air should be followed.
8. Interior temperature readings should be taken every ten days to two weeks.
9. If the pile has heated to 150 or 160 deg. F., it should be moved.
10. If water is to be used, soak the coal, break through the coke that is sometimes formed over and around the heated part.

Norwalk Iron Works Refrigerating Machine

The Norwalk Iron Works, of South Norwalk, Conn., well-known builders of air compressors, have entered the refrigeration field. For the present, at least, this company will confine itself to small machines from one-quarter ton up. The illustrations show clearly the construction. The long pistons are actuated by connecting rods which get their motion from eccentrics on the shaft (see Fig. 1). The suction gas enters through ports in the piston, which uncover on the suction stroke. The gas fills the space in the piston and compresses until the pressure overcomes the condenser pressure and weight of the valve. The valve area is large.

The ring on the base of the connecting-rod slips over a loose ring which in turn fits over the body or disc of the eccentric, the middle ring, as a bearing, being of babbitt metal. This bearing is retained by a lip on the inner edge of the eccentric-shaft ring and a similar lip on the outer edge of the connecting-rod ring.

Lubricant is supplied through holes in the inner and outer rings. The crankshaft journals have bearings of the same loose-ring type. On the inside of the housing, where the crankshaft passes through, there is a babbitt ring floating on the shaft which is forced by the pressure of the gas within the housing, against the stuffing box. The pressure put on the stuffing box in packing it is limited by a spring between the stuffing-box outside cap and the packing. The crankshaft bearings are of the loose ring or shell type. Fig. 2 shows a complete small motor-driven refrigerating plant.

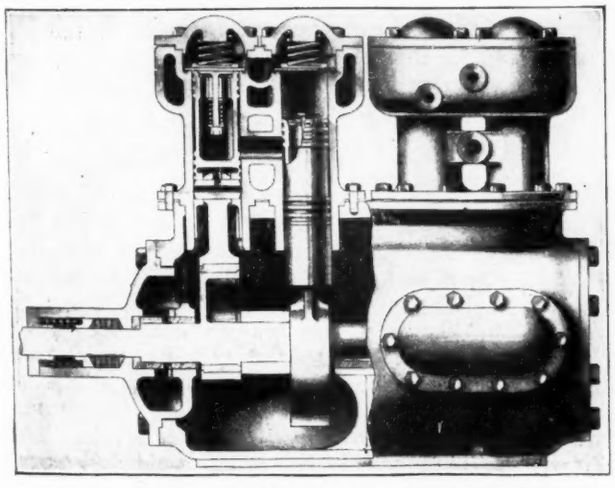


FIG. 1. SHOWING SECTION OF THE COMPRESSOR

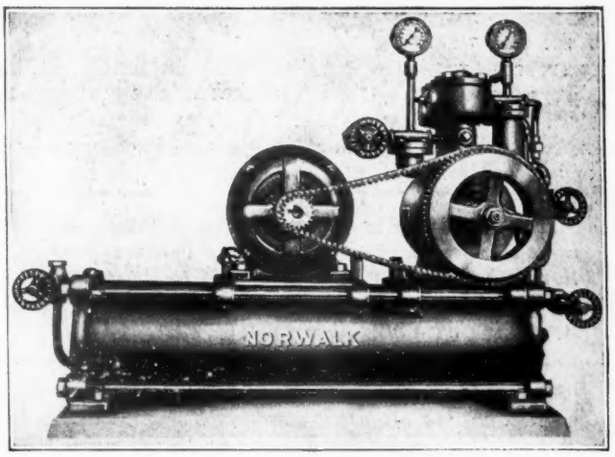


FIG. 2. COMPLETE SMALL REFRIGERATING PLANT

For lubrication a graphite mixture is used instead of oil. The aim is, of course, to avoid carrying oil into the ammonia system, also to avoid volatilization of the lubricant. The housing is packed with graphite which, the builders claim, will last for many months.

Ice-freezing tanks and complete small self-contained plants are built by this company.

Diesel-Engine Pointers

The main-bearing oil grooves should be examined at frequent intervals. Small carbon particles often choke up the passages.

The bearing cap studs should always be locknutted and cotterpinned.

In cutting grooves in rebabbitted bearings, never extend them to the edges of the bearing. This will prevent a too free escape of the oil.

Each time the crankpin bearing is taken out, caliper the bearing to see if it has belled. If the bearing is larger at the ends than at the middle, it will likely begin to run hot. What causes belling is unknown—probably the result of the crank and piston-pin bearings being out of line, or side shifting of the mainshaft.

The Diesel engineer should remember that as the crankpin and piston-pin bearings wear, the connecting rod is shortened. This wear increases the clearance in the cylinder, decreasing the compression. Each time the wear is taken up, the rod end should be shimmed back to its original length.

In tightening up the big end bearing bolts, a heavy hammer can be used on the wrench. The locknuts must be drawn tight and cotter pins used. Washers can be placed between the nuts and cotter pin to fill the space.

The crank bearing should have but little play. A clearance of 0.006 in. is ample. If a slight movement can be detected when jumping with a bar, the clearance is sufficient.

The Air Lift

By A. H. BLAISDELL
Assistant Professor Mechanical Engineering, Carnegie Institute of Technology

It is the aim of the following discussion to give in as simple a manner as possible a brief explanation of how the air lift works, and to indicate in a general way how to carry out calculations in connection with this apparatus.

AS a means of pumping liquids from deep bore-holes or wells the air-lift system is excellent. Not economy but expediency appears to be the governing factor in the use of air-lift apparatus. Thousands of installations scattered over the globe testify to the great success of this method of pumping water, oil, liquid sulphur, etc. In spite of its extensive use there has been little investigation of the air lift and there are few engineers that claim to know much about this method of pumping.

Operating Principle

Referring to *A*, Fig. 1, this represents a well of great depth as compared to diameter, the diameter of such holes ranging from 6 to 12 in. and the depth from 500 to 1,500 ft. or more; *B* is a pipe of large diameter

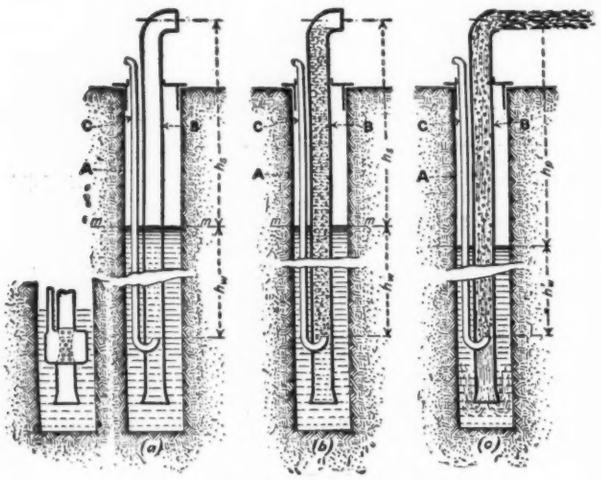


FIG. 1. SECTIONS OF THE AIR LIFT

which projects down into the well to any desired extent; *C* is a pipe of smaller diameter than *B* and not quite so long; its lower end may project into pipe *B* as shown or into a chamber which connects with *B* by means of a number of small holes (see diagram to left of *A*). At *mm* is the water level in the well when no water is being pumped, the water standing to the same level on the inside of pipes *B* and *C* as on the outside.

Now suppose that air under pressure is supplied to the pipe line *C:* as the pressure of the air in *C* is gradually increased, the water level in this pipe is lowered until finally it reaches the end of the pipe. It is quite evident that the air pressure at this instant must be equal to the pressure due to the head of water h_w. Any further increase of air pressure will now cause the air to push the remainder of the water out of *C* and the air will start to ascend in pipe *B* in the form of bubbles. The effect of this action will be to lengthen out the fluid column in *B*, although the water level outside of *B* remains unchanged. The level of the aërated column of water finally reaches the top of pipe *B* and at this point we have then a column of water h_w feet in length supporting a column of air and water $(h_s + h_w)$ feet in length. The instant that overflow occurs at the discharge end of *B* the pressure is relieved on the upper portion of the fluid column in *B*, the air bubbles rapidly expand and water is blown out from the upper end of *B* followed by a vigorous and continued discharge of aërated water *C*, Fig. 1, which is maintained as long as air is supplied to the system.

With the beginning of flow the level of the water in the well on the outside of *B* will drop from 15 to 20 or more feet, depending on the geologic formation of the strata which supplies water to the well and to the rate at which water is being removed from the well. The distance from the new level of the water to the center line of the jet is known as the pumping-head or lift (h_p); see *C*. It will always be greater than the static head (h_s). The distance (h'_w) is called the submerged head and is customarily given in terms of a percentage.

Before flow begins, the air serves only to lighten the column of water in *B*, but with the commencement of flow it really performs two functions—to maintain a fluid density for the air and water mixture less than that of the water, and at the same time to furnish a portion of the motive force required to keep up a continuous discharge of water from the discharge pipe *B*. Some authorities have argued that the motive force is due entirely to the difference in density of the fluid columns within and without the pipe *B*, while others have claimed that it is the buoyancy of the air bubbles which supplies this motive force. It seems resonable to suppose that both these effects occur simultaneously, although the former predominates over the latter to a greater or lesser extent, depending on circumstances.

To secure as much lifting effect as possible from the buoyancy of the bubbles, it is desirable to reduce the slippage of the latter as they move upward through the water in *B*. The larger the slip or relative velocity of the air with respect to the water, the greater the loss of energy. The slip increases with the size of the air bubbles, and for that reason it seems best to supply the air to the water in the lower end of the discharge-pipe, in a finely dispersed state.

Submergence Varies with the Lift

It is quite evident that the greater the lift (h_p) the larger the submergence must be, since it is due to the difference in weight of the aërated column of water inside of pipe *B* and the solid water on the outside of this pipe that flow from the discharge pipe *B* is sustained. What the submerged head (h'_w) should be, for a given well, can be ascertained only by actual test. Apparently, it is influenced by the quantity and rate at which water is taken from the well and the volume furnished to the well by the water-bearing strata. The difference in head $(h_w - h'_w)$ is approximately equal to the drop in the air pressure at the instant that pumping begins and is different for each well. Formula

(1) can be used to estimate this drop when the change in air pressure is known or assumed.

$$h_w - h'_w = 144 \times \left(\frac{p_2 - p_1}{d}\right) + \frac{v^2}{2g} \qquad (1)$$

h_w = Head of water in feet on end of air pipe before pumping begins;
h'_w = Head of water in feet on end of air pipe after pumping beings;
v = Velocity of fluid mixture at point where air enters discharge pipe (feet per second);
d = Air density in pounds per cubic feet (see table);
p_2 & p_1 = Pressures of air before and after delivery begins in pounds per square inch absolute respectively.
g = 32.2

The fact that the air pressure necessary to keep the air lift in operation is less than that required to start the apparatus is because energy is consumed in overcoming the initial inertia of the water in the discharge pipe and setting it into motion. After flow has once been established, this additional energy is no longer required and hence a lessening of the air pressure results. Of course the drop in pressure will also be influenced by the resistances which the water may have to overcome when entering the lower end of the discharge pipe, such as strainers, etc. It is this change in h_w that makes air-lift estimates so uncertain, and for that reason experience is necessary before one can expect to design or install such pumping outfits with reasonable expectation of success.

In making preliminary calculations, the submerged head (h'_w) can be assumed as ranging from 0.5 to 0.6 times $h'_w + h_p$. In this connection the submergence curve of Fig. 2 can be used to advantage. This is a composite curve based upon results of various tests made by E. M. Ivens on different types of air lifts, and represents in a general way how the percentage of submergence should vary with the lift. It can be taken for granted that the higher the lift the greater will be h'_w, but the smaller will be the percentage of submergence.

Size of Discharge Pipe

The size of the discharge pipe will be governed by several factors—the diameter of well, rate of water delivery, and allowable velocities of fluid mixture in the discharge pipe.

The size of the well-bore is fixed, but the rate of delivery and the velocities admit of some variation. When deciding upon what velocity value shall be assumed for the discharge pipe, it must be borne in mind that a large area of pipe means a low water velocity with small friction loss in so far as the water is concerned; but this gain is offset by the greatly increased slip of the air bubbles, this slippage increasing as the discharge pipe is enlarged.

The velocity of the air and water mixture at the upper end of the discharge pipe will be from three to four times that in the lower portion of the same pipe (if the pipe is of constant diameter throughout) due to the expansion of the air bubbles as they ascend in the discharge pipe and reduce the effective area for the flow of water. It will serve for most purposes to assume a velocity of from 6 to 8 ft. per sec. for the lower end of this pipe and 18 to 26 ft. per sec. for the upper end. A gradual increase of velocity can be secured by making the discharge pipe taper from bottom to top.

The quantity of water and air in cubic feet passing by the lower end of the air pipe is given by

$$Q = Q_w(7.48\, q \frac{p_1}{p_2} + I) \qquad (2)$$

where
Q = Cubic feet per second of water and air;
Q_w = Cubic feet per second of water pumped;
q = Cubic feet of free air per gallon of water pumped;
p_1 = Atmospheric pressure in lb. per sq.in. abs.;
p_2 = Pressure at lower end of air pipe in lb. per sq.in. abs.

Formula 2 applies to but one section of the discharge pipe; for any section of this pipe located y feet

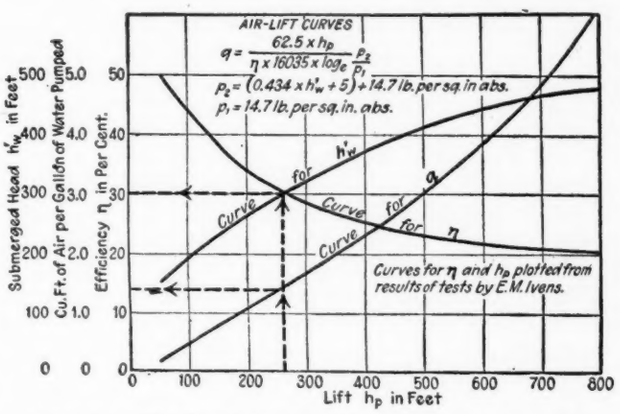

AIR-LIFT CURVES
$q = \frac{62.5 \times h_p}{\eta \times 16035 \times \log_e \frac{p_2}{p_1}}$
$p_2 = (0.434 \times h'_w + 5) + 14.7$ lb. per sq. in abs.
$p_1 = 14.7$ lb. per sq. in. abs.
Submerged Head h'_w in Feet
Cu. Ft. of Air per Gallon of Water Pumped
Efficiency η in Per Cent.
Curve for h'_w
Curve for q
Curve for η
Curves for η and h_p plotted from results of tests by E.M. Ivens.
Lift h_p in Feet
0 100 200 300 400 500 600 700 800

FIG. 2. CURVES TO ASSIST IN DESIGNING AIR LIFT FOR WATER

from the lower end of the air pipe, the density of the fluid mass is less than it was lower down in the pipe and Q becomes greater although the weight of fluid discharging from the pipe per second remains constant.

The diameter of the discharge pipe is given by

$$D = 0.62 \sqrt{\frac{G\left(7.48\, q \frac{p_1}{p_2} + 1\right)}{V}} \qquad (3)$$

where
D = Diameter of discharge pipe in inches;
V = Velocity of fluid mixture in lower end of discharge pipe in feet per second;
G = Gallons of water pumped per minute.

The value of D given by this formula must be less than that of the well by 3 to 5 in. A suitable value of V for the lower end of the discharge pipe can be assumed as already mentioned, but should never exceed 10 ft. per sec. As a rough estimate one can allow about one square inch of free cross-sectional area for discharge pipe for every 12 to 18 gal. of water pumped.

Cubic Feet of Free Air per Gallon of Water Pumped

An uncertain item in air-lift calculations is the quantity of free air required per gallon of water pumped from the well. It will be influenced by the capacity of the installation, the submergence, the sizes of the air and discharge pipes, etc. It is practically impossible to deduce a theoretical relationship between the air supplied and the water pumped that can be at all reliable, and for that reason it is customary to use empirical formulas which check fairly well with tests of actual installation. One of the best known is that originated by Edward Rix and T. H. Abrams. In this case, however, I shall utilize the following expression which

relies for its accuracy on the relation between (h'_w) and the efficiency (η) as determined from tests on air lifts. The formula is

$$q = \frac{62.5\ hp}{\eta \times 16{,}035 \times \log_e \frac{p_2}{p_1}} \qquad (4)$$

where q = cubic feet air per gal. water pumped; h_p = lift in feet; $p_2 = (0.434\ h'_w + 5) + 14.7$ lb. per sq.in. abs.; p' = atmospheric pressure in lb. per sq.in. abs. Values of q as calculated from this formula compare favorably with those secured from empirical formulas in use at present. The curves of Fig. 2 show the variation of η q and h'_w and h_p. The data for the h'_w and η curves were taken from tests made by E. M. Ivens. The η curve is of a composite nature and gives average values covering several different types of air-lift installations. It will be observed from these curves that as h_p increases, the submergence h'_w gradually grows, while the efficiency drops off rather abruptly at first and then quite slowly. The cubic feet of free air required per gallon of water pumped is least for low lifts and a maximum for high lifts.

As the curve for q is based on test results, it is not necessary to increase q in figuring the required air compressor capacity, since this curve includes the effect of volumetric efficiency of the average compressor.

The air pipe must be of such size that the velocity of air flow shall not exceed about 3,000 ft. per min. Velocities in excess of this cause a considerable drop in the air pressure between the compressor and the end of the air pipe, particularly for long pipes. It is customary, in practice, to make the area of the air pipe about one-sixth that of the discharge pipe, but if the former is very long it is well to calculate the probable drop in pressure.

Air-Lift Efficiency

The efficiency of an air lift is usually stated as the ratio of the work done in lifting W lb. of water through the height h_p and the expansion work of the air while passing up through the discharge pipe. Expressed mathematically, it is

$$\eta = \frac{212 \times h_p}{q \times d \times T \times \log_{10} \frac{p_2}{p_1}} \qquad (5)$$

where η = efficiency in per cent; h_p = pumping head in feet; d = density of air taken in by compressor, in lb. per cu.ft. (see Table I); p_2 = air pressure at base of air-pipe in lb. per sq.in. abs. ($= 0.434\ h'_w + 5 + 14.7$); p_1 = atmospheric pressure in lb. per sq.in. abs.; T = temperature of water in well in deg. F. abs.; q = cu.ft. of free air per gal. of water pumped.

This formula is based upon the assumption that the air expands isothermally while rising up through the discharge pipe. A more exact expression for the efficiency would be one that considered the compression work done by the air compressor rather than the expansion work of the air in the discharge pipe.

An examination of the efficiency curve of Fig. 2 shows that the efficiency of an air lift will vary between 50 and 20 per cent, the higher values accompanying the lower lifts. The low average efficiency is offset by the great advantage of having an outfit which does not require constant tinkering. An air lift can handle dirty, gritty or acid water with equal facility. As a matter of fact its over-all efficiency is as good as, if indeed not greater than, that of any pumping apparatus that could be used for the purpose of raising fluids from great depths.

Suppose that a well, 10-in. bore, is to be equipped with an air-lift system. If the distance to the water level from the ground surface is 242 ft., what will be the probable total length of the discharge pipe and air pipe, air-compressor capacity in cubic feet per minute, sizes of both pipes, and efficiency of installation? Well capacity to be 200 gal. of water per min.

The effective length of the discharge pipe equals the lift plus the submergence. The lift or pumping head (h_p) will be greater than h_s, but just how much it is impossible to say. We will assume a drop in the water level of the well of about 20 ft. when pumping begins. In that case the pumping head can be estimated as about $242 + 20 = 262$ ft. Referring to the (h'_w) curve of Fig. 2, we find that for $h_p = 262$ ft. $h'_w = 300$ ft. Hence the effective or working length of this pipe must be at least $262 + 300 = 562$ ft., and since the lower end of the pipe will be anywhere from 5 to 20 ft. below the air-pipe connection to the discharge pipe, we can estimate the total or over-all length of this pipe as being $562 + 10 = 572$ ft., from which fact it is evident that the well must have a depth of from 575 to 580 ft.

The air-pipe length will be exclusive of that portion above the ground surface, 562 ft.

From the q curve of Fig. 2 we observe that for $h_p = 262$ ft. q or the free air required per gallon of water pumped, is 1.33 cu.ft., or a total of $200 \times 1.33 = 266$ cu.ft. per min., and this must be the air-compressor capacity.

For (h'_w) equal to 300 ft. p_2 is

$p_2 = 300 \times 0.434 + 5 + 14.7 = 150$ *lb. per sq.in. abs.*

and the diameter of the discharge pipe must be from formula (3)

$$D = 0.62 \sqrt{\frac{200\left(7.48 \times 1.33 \times \frac{1}{10} + 1\right)}{6}} = 5.07\ in.$$

That is, allowing for friction, etc., about a 6-in. pipe would undoubtedly fill the bill provided the velocity in the upper portion of the pipe does not exceed 30 ft. per sec. To check this, let $p_2 = p_1$. Then if $D = 6$ in. we find, on re-arranging formula (3) and solving for V, that

$$V = \frac{0.384 \times G\left(7.48 \times q \times \frac{p_1}{p_2} + I\right)}{D^2} =$$

$$\frac{0.384 \times 200\left(7.48 \times 1.33\ \frac{1}{10} + I\right)}{36} = 23.4\ ft.\ per\ sec.$$

Evidently, with a 6-in. pipe the velocity in the upper portion of the discharge pipe will be considerably less than 30 ft. per sec., and we may consider this size of pipe as satisfactory.

If the area of the air pipe is taken as one-sixth that of the discharge-pipe, then

$$D_a = \frac{D}{\sqrt{6}} = \frac{6}{2.45} = 2.45\ in.$$

That is, a standard 2½-in. pipe is required.

The efficiency η will be, from efficiency curve of Fig. 2, about 30 per cent.

Temp., Deg. F.	Weight of One Cu. Ft. of Dry Air (at 14 Lb. per Sq.In. or 28.5 In. of Hg.), Lb.	Increase or Decrease of Weight for Each 0.1 Lb. Change in Pressure, Lb.
32	0.07688	0.000549
35	0.07642	0.000546
40	0.07565	0.000540
45	0.07490	0.000535
50	0.07417	0.000530
55	0.07340	0.000525
60	0.07272	0.000520

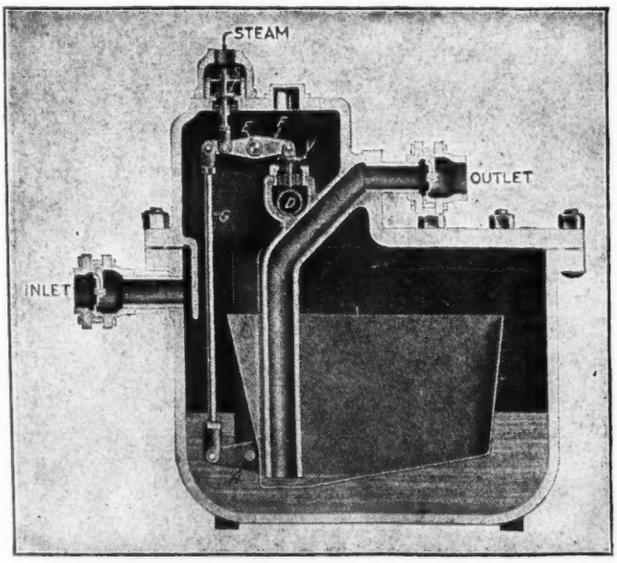
Strong Vacuum and Pumping Trap

This trap, "Type M," is designed for draining exhaust lines to condensers or for draining any system under any degree of vacuum, such as the receiver of a compound engine or the receiver between an engine and exhaust or low-pressure turbine, whether the receiver is under pressure or under vacuum. It will also drain vacuum oil separators and deliver the water to any distance or any height, limited only by the steam pressure available.

This trap, designed by L. A. H. Merrihew and manufactured by the Strong, Carlisle & Hammond Co., Boston, can also be used as a pumping trap, as it will take the water from low-pressure or gravity-heating returns and pump it anywhere, limited only by the available steam pressure. It will also serve as a sump pump.

The principal parts of the trap are the body, cover with valve chamber, open float bucket, vacuum or equalizer valve, steam valve and valve-operating connections. The steam and equalizer valves are both connected to the valve rocker arm *F*, which swings on a bearing at *E*. The bucket is hinged at *H* to an extension from the trap cover and is connected to the valve rocker arm by the valve-operating rod *G*.

The illustration shows the trap in the filling position. The bucket is up and afloat. The steam valve *S* is on its seat, and the equalizer valve *V* is open. Water comes into the trap, fills the bucket, which sinks and pushes up the rod *G*, closing valve *V* and opening valve *S*. The valve *V*, in closing, cuts off the trap from equalizer pipe; valve *S*, opening, admits live-steam pressure to the trap and discharges it from inside the



SECTION THROUGH VACUUM AND PUMPING TRAP

bucket, through the outlet pipe. The bucket, becoming empty, floats and reverses the valves to the filling position. When live steam is admitted to the trap, it cannot go out through the inlet because of the check valve. After the trap has discharged and the steam is cut off by the rising of the bucket, the steam pressure in the trap equalizes back into the system or exhausts through the equalizer port, as the case may be. The trap then functions in this manner continually. A check valve in the discharge cuts off any air or back flow from the discharge line.

Hydraulic Turbines in the Rural Districts About 1830

As illustrating the "state of the art" some eighty or ninety years ago in backwoods New England, the following true story may be worth recording. It was told to the writer by Z. Coffin, founder of the Coffin Valve Co., of Neponset, Mass., many years ago.

There were two men in his town, an old conservative and an enterprising young man, who owned a sawmill

"THAT IS BECAUSE YOU WERE SO GOL-DURNED MEAN TO ME ABOUT PUTTING IN A NEW WHEEL"

in common and operated it in alternate weeks. The output of the mill did not satisfy the younger man, so he proposed to his colleague that they should put in a better turbine wheel, which he thought could be bought in the market. But the old man would not agree to this proposition.

"You can put in a new wheel, if yer want to," said he, "but you must put it in, in your week. And you must keep the old wheel in good shape and put it back again, if the new wheel is no better than the old one, in your week."

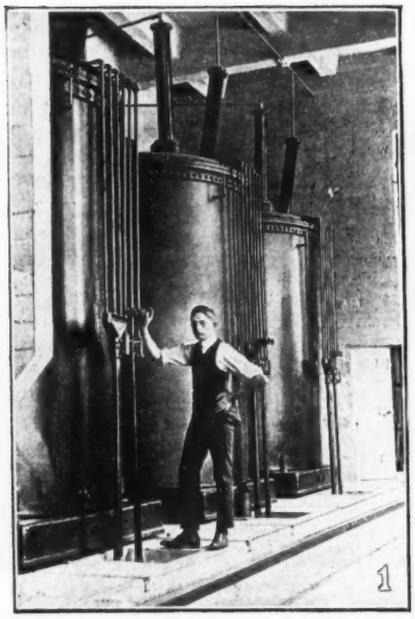
That was not very encouraging, so the young man did the next best thing and, experimenting, soon found that the efficiency of the whole plant was improved when he smoothly plugged up some quarter part of the guides; or perhaps it was of the buckets, "undergating" and "overgating" being common defects at the time. But he said nothing about it to anybody, and at the end of his week took the plugs out again. The result was that the old man soon noticed that there was something mysterious about the output of that sawmill which he couldn't account for.

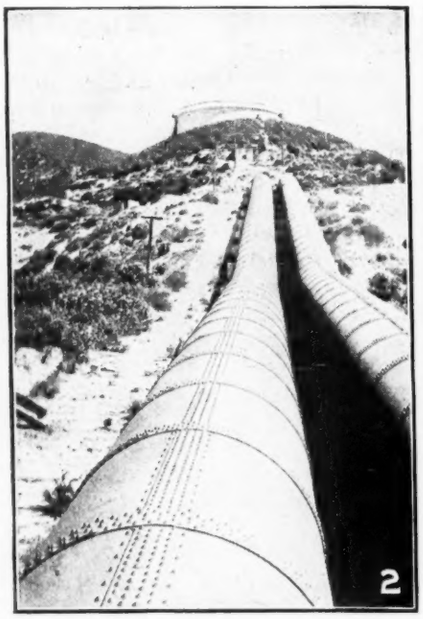
"How is it," he said to his fellow-owner, "that in your week the saw seems to buzz faster and that you always turn out more sawed stuff in a week than I am able to turn out?"

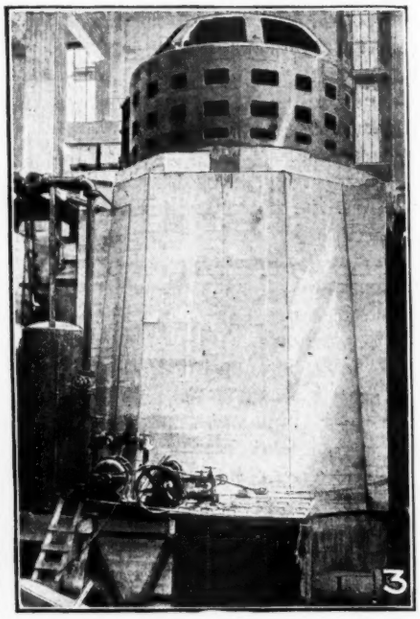
"Don't you know why that is?" asked the younger. "That is because you were so gol-durned mean to me about putting in a new wheel. It is a punishment from God Almighty."

This did not seem rational to the older man, but when it continued week after week, it at last brought him around. The old wheel was taken out at the close of one man's week, and a new one installed in the beginning of the other man's week; the weekly output of sawed stuff was permanently increased, and presumably they lived happily ever after.

Views of Power Equipment Along the Los Angeles Aqueduct System







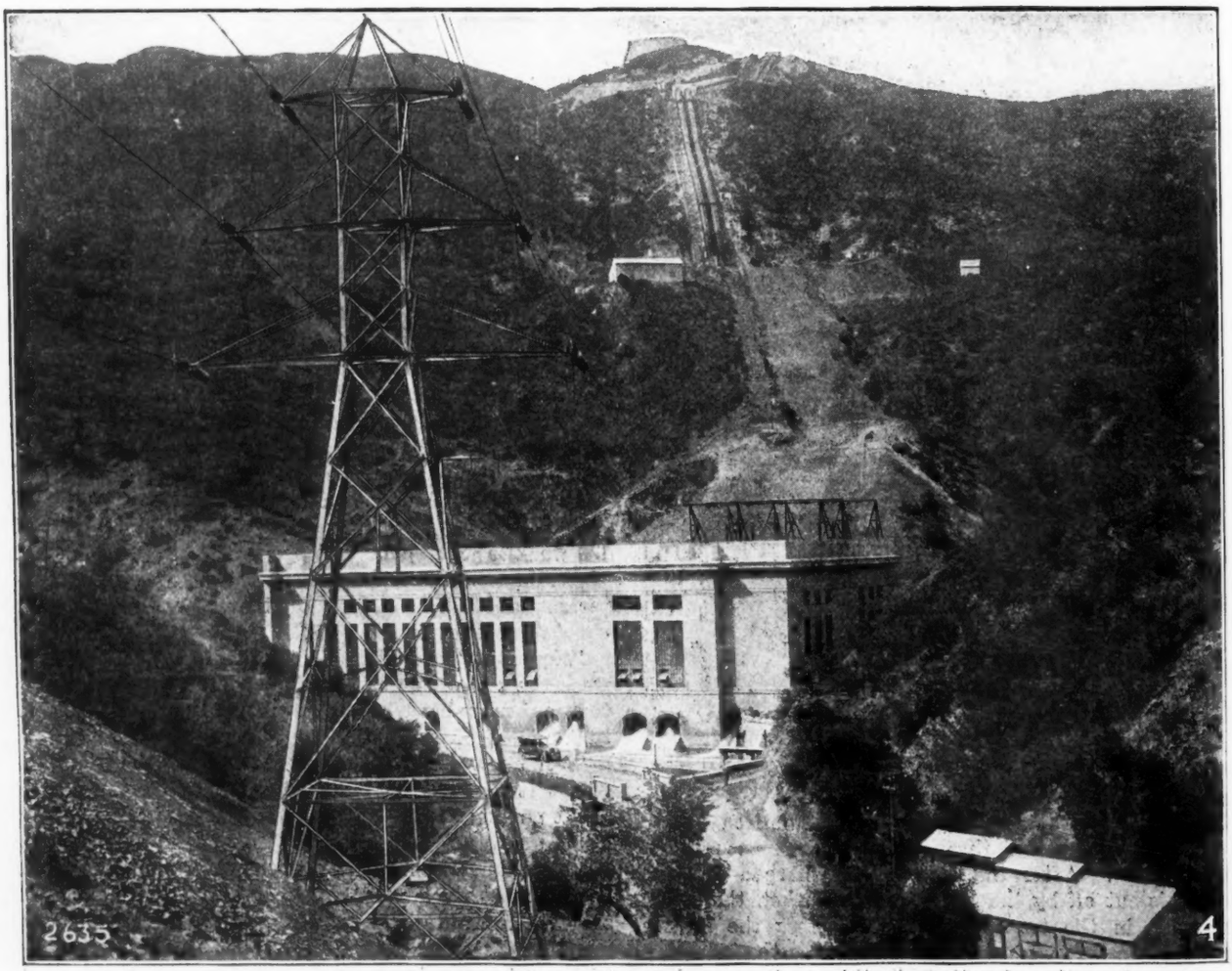


FIG. 1. THREE 110,000-VOLT TRANSFORMERS. FIG. 2. PART OF PENSTOCKS AND SURGE CHAMBER AT NO. 1 PLANT.
FIG. 3. TURBINE INCASED IN CONCRETE WITH STATOR FOR 15,000-KVA. GENERATOR IN PLACE.
FIG. 4. SAN FRANCISQUITO (LITTLE ST. FRANCIS) POWER HOUSE NO. 1

Ice Tank of New Design Gives Remarkable Results

By C. WILKIE
Engineer, Finney Avenue Plant, Merchants Ice and Coal Company, St. Louis

DURING the season of 1919 it was decided to increase the capacity of the ice-freezing tanks in the Finney Avenue Plant of the Merchants Ice and Coal Company, St. Louis, Mo., the location of the new tank being the first question to be determined. In the June 22, 1920, issue of *Power* a general description of the plant was published. The reader may remember that there were three freezing tanks, each 79 ft. long and wide enough to hold eighteen 400-lb. cans in a row. To build a new tank by the side of the old ones it would have been necessary to extend the building on that particular side, and to locate the new tank under one of the old ones would have deprived the plant of an ice-storage house having a volume of 58,000 cu.ft. At one end of the older tanks was an unoccupied room which would give ample space for extending the old tanks 35 ft. and at the same time provide the necessary space for ice conveyors to carry the ice to the storage rooms below.

This ice tank is 114 feet long, holding 856 cans, freezing 400-pound blocks. Direct-expansion coils are in one end, flooded coils with horizontal accumulator in the other end. Seven inches of agitation is produced by one propeller, 36 inches in diameter, at the center of the tank. Special floor design, cans four inches higher than usual and means for holding cans vertical permitted this rapid circulation. Other features are eighteen-can pneumatic crane and spring-bottom dumps. New tank shows heat transfer of 40 B.t.u., a remarkable performance.

Extending the old tanks was much the cheaper plan, although it would make an excessively long tank, calling for a coil 1,500 ft. long, provided the coil ran the full length of the tank. During the winter of 1919-20 one of the tanks was extended and the coils, propellers and pipe connections were rearranged. The results obtained from the new tank during last season were so much above expectations that the other two tanks are being rebuilt along the same lines. After removing the old coils, the tank was raised 3½ ft. by means of 1⅛-in. continuous threaded rods, which were put through timbers above and passed through 6 x 6 x ⅝-in. angles 10 in. long, bolted to the side of the tank, with a takeup nut on the bottom side of the angle, as shown in Fig. 2. With a man at each rod the tank was raised to the proper height and blocked up in a short time. The addition was made and the coils arranged as in Figs. 3, 4 and 5. To preserve the efficiency in a freezing tank of such length, it was considered necessary to make one end of the tank direct-extension, with double coils, and to expand 100 per cent excess liquid through them. This end of the tank was practically flooded and really better than a regular flooded coil, as it would have higher internal velocity. The opposite end of the tank was arranged to operate on the flooded system, as it made possible the use of a short coil in which each foot of pipe had a decided pitch. This coil will be used to evaporate the 100 per cent excess liquid fed to the opposite end of the tank. With the arrangement outlined it was possible to use a horizontal accumulator in the place of headers, and it was made of large capacity to insure delivery of dry saturated gas to the machine. Inlet headers and check valves are used on practically

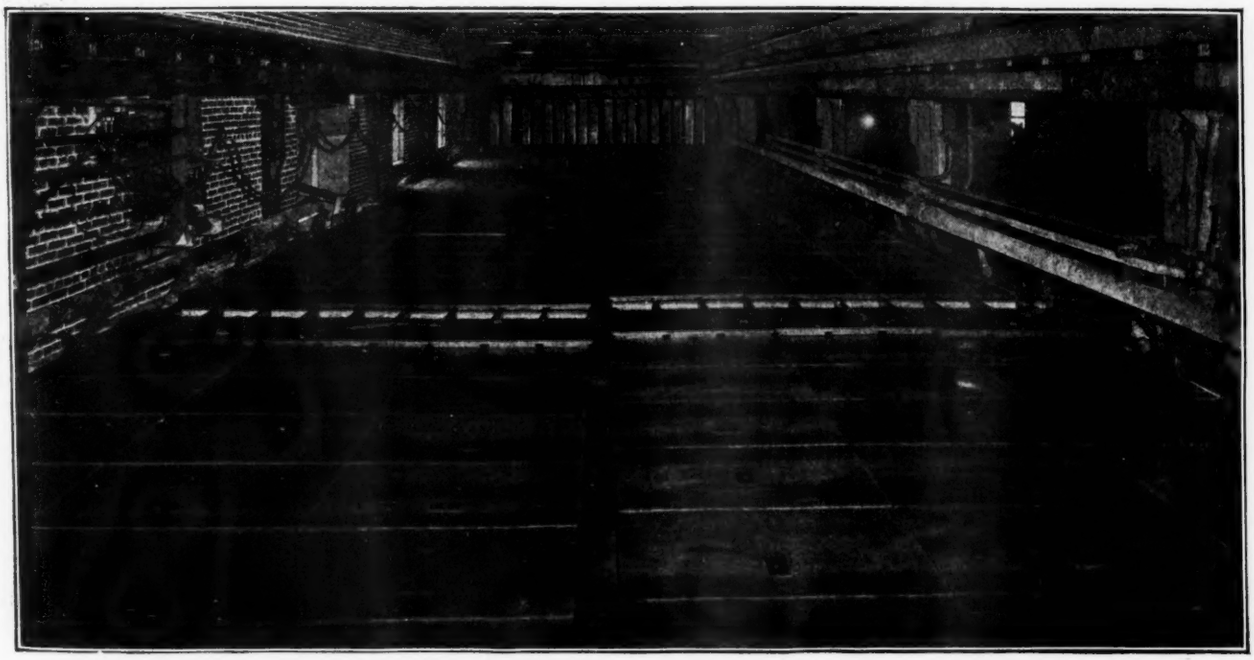


FIG. 1. NEW ICE TANK FOR FINNEY AVENUE PLANT, 114 FT. LONG

all flooded systems, as it has been proved by tests that there is a periodic kick-back in the circulation of ammonia. The ammonia evaporates in the coils faster

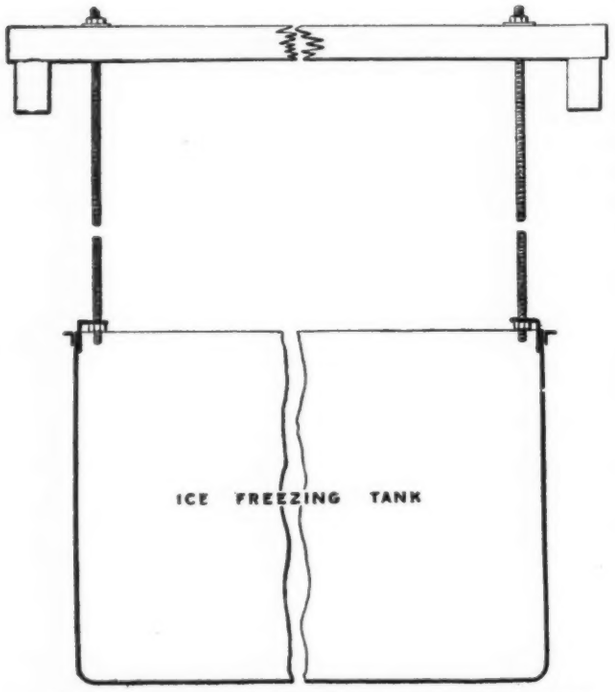


FIG. 2. METHOD OF RAISING ICE-FREEZING TANK

than it can flow steadily forward. Thus the closing of the check valve against its return accelerates the forward circulation. In the present case the check valves and headers were not installed because it would have been necessary to shorten the tanks two or three rows of cans to get the necessary alley. The difficulty was overcome by using short and steep flooded coils, on the ground that if the coils were short enough and had sufficient pitch there would be no kick-back and no necessity for check valves. This arrangement also reduced materially the cost of construction.

While these tanks were being designed, the idea was conceived that the cause of most of the flooded-system failures was due to excessively long coils and to small accumulator capacity. The latter difficulty was solved by building an unreasonably large accumulator and placing it horizontal so that its separating area would be as large as possible. It was expected that even with this arrangement the machine would get wet gas and that possibly a drier or superheating accumulator would have to be installed in the main suction line. Results obtained so far have proved that such a precaution is unnecessary.

The expansion header is made of 5-in. single-strength pipe, drilled and tapped for 1¼-in. nipples, 7¼-in. centers, to receive the two connections from each double coil. Ninety degrees from the coil connections and six feet from either end, 1¼-in. nipples have been inserted for expansion-line connections. The nipples were screwed into the header and welded, and ⅜-in. firebox steel plates were welded to each end. The header lies in the bottom of the tank and feeds the two bottom pipes of each double coil. This gives an even ammonia feed for each coil as the header is half full of liquid before any of the coils can receive any of the fluid. The suction header for the direct-expansion coils is made up of 7-in. single-strength pipe drilled and tapped for 1¼-in. nipples, which are made up and welded. The continuation of this header connects with the accumulator.

In the direct-expansion end of the tank the coils are double; that is, two coils in one, each 376 ft. long. U-bends of 5- and 13-in. radius were used to make up the coils. The latter are welded throughout except where

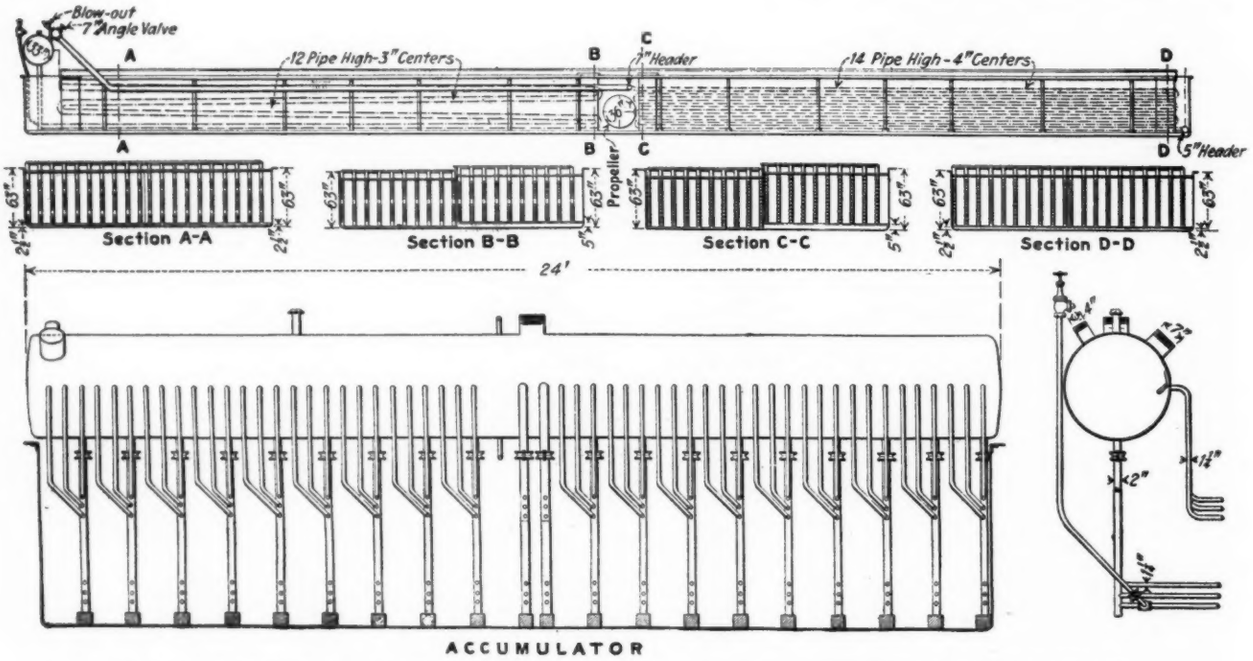


FIG. 3. GENERAL LAYOUT OF ICE TANK AND CONNECTIONS TO HORIZONTAL ACCUMULATOR

they are connected to the expansion header, steel flanges being used here.

In the flooded end of the tank triple, or three-in-one, coils are used, each 220 ft. long. The liquid ammonia

for the flooded end passes through the direct-expansion coils, then through the 7-in. line to the accumulator. From this point it is gravity-fed into the bottom of the flooded coils, and the gas passes from the coils back into the side of the accumulator above the liquid level. These coils have a gradual incline of about $\frac{3}{32}$ in. to the foot. Fig. 3 shows the accumulator, which was made of $\frac{1}{2}$-in. marine steel plate with welded seams. The 2-in. liquid feeds, which are welded to the bottom of the triple coils, are insulated and made waterproof so as to prevent any of the liquid ammonia from evaporating before it enters the coils. A 10-in. dry pipe was placed inside of the accumulator with a 7-in suction connection leading from it. The dry pipe has a slot one inch wide for its full length through which the gas must pass before it can enter the suction line. To get liquid to the compressor would require that the accumulator be practically full of liquid ammonia. A $1\frac{1}{4}$-in. blowoff connection was made to the bottom pipe of the triple coils. The main suction header and line to the compressor room is 12 in. in diameter and passes above the accumulators. The connections between the accumulators and the header are 7 in. in diameter. The suction does not pass through any forecooler, and yet with this arrangement it is difficult to freeze back to the compressor.

The propeller was designed on the theory that higher efficiency can be secured with a large unit than with several small ones. In present-day practice there is too much room for slippage between blades and the blade tip speed is so high as to cause cavitation.

Fig. 6 shows the propeller. It is 36 in. in diameter and has three blades made of $\frac{1}{4}$-in. steel plate welded to a piece of 8-in. pipe, 18 in. long, which has solid heads in either end and is bored for a $2\frac{1}{16}$-in. shaft. This completes the hub, which is keyed on the shaft and held against a shoulder by means of a jam nut on the end of the shaft. The propeller has a blade-tip speed of 16 ft. per second, and is located in the center of the tank. It produces seven inches of agitation or one inch to seven cans. The wall of the tank was made four to six inches higher on the high brine side to take care of the high agitation. The tank floor was raised five inches on the high-brine side immediately in front of the propeller, with a fall of $2\frac{1}{2}$ in. from the center to each end of the tank and also a $2\frac{1}{2}$-in. fall from each end to the center of the tank immediately behind the propeller on the low-brine side. The floor on the high-brine side was made of concrete, that on the low-brine side of yellow pine.

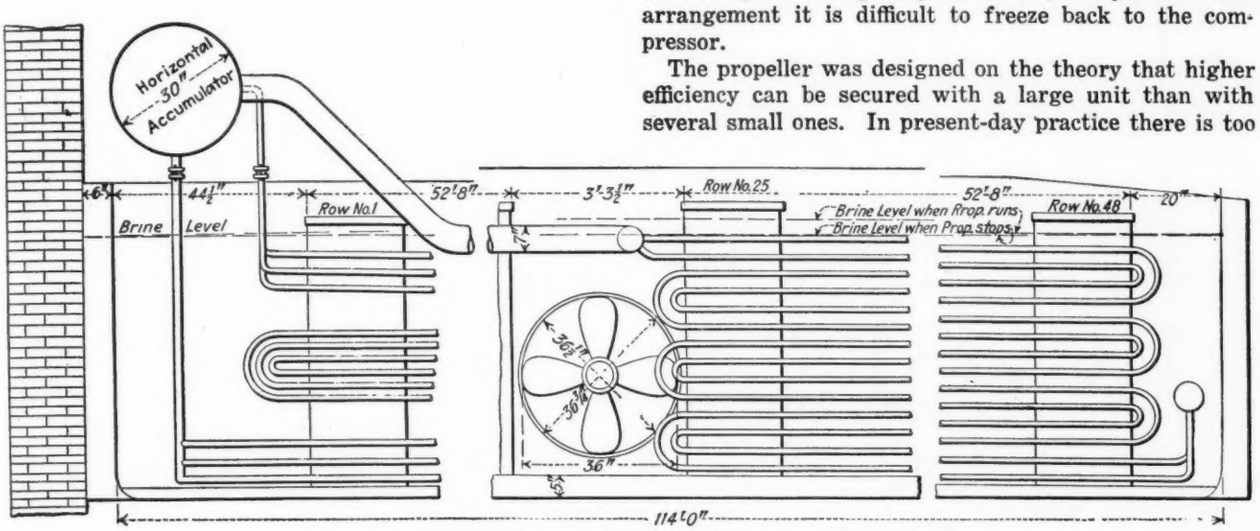


FIG. 4. CONNECTION OF FLOODED COILS TO ACCUMULATOR

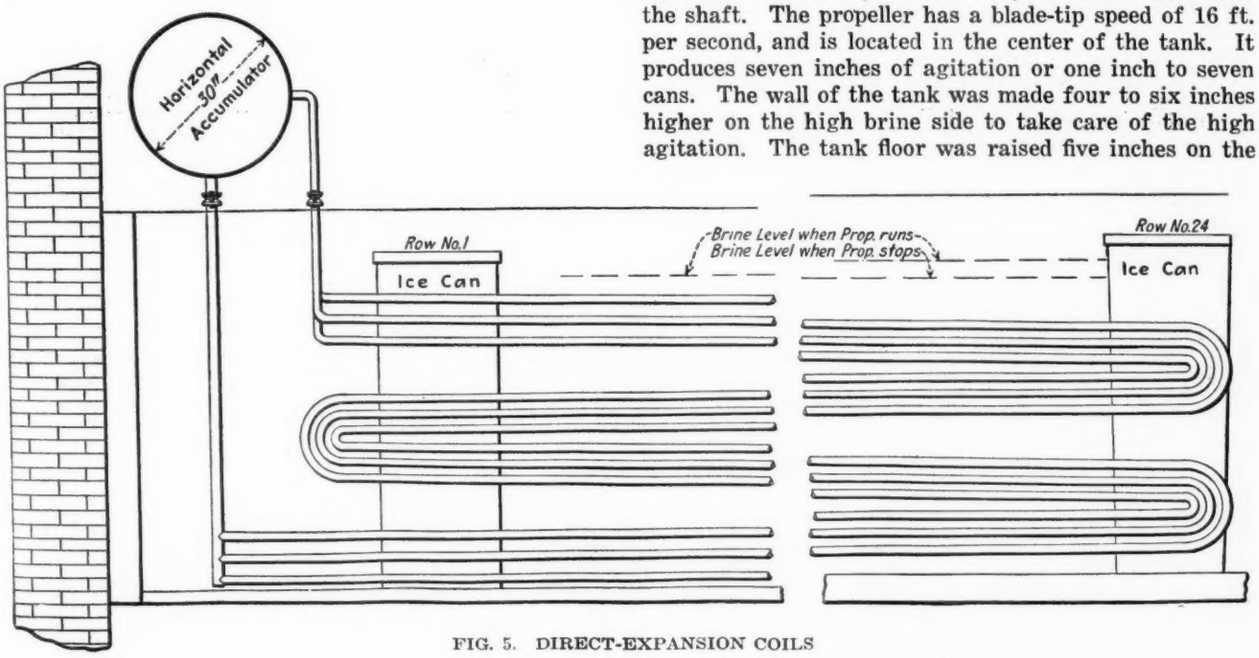


FIG. 5. DIRECT-EXPANSION COILS

New cans four inches longer than the old ones were ordered, the extra length costing but little more. This seemed to be the best method to meet the high-brine circulation. With cakes of ice 53 in. long, cans 62 in. deep and special tank-floor design, it was easy to get from seven to nine inches of agitation and keep the brine above the ice without flooding over the top of the cans, whether the propeller was running or standing. The propeller is motor driven and takes about 7¾ hp. motor input.

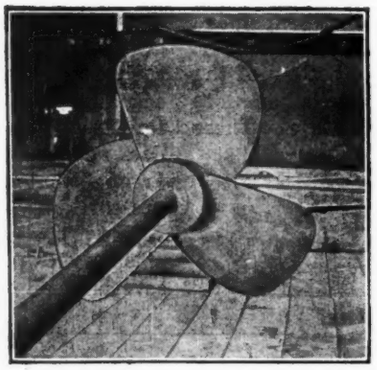


FIG. 6. SINGLE 36-IN. PROPELLER USED TO CIRCULATE BRINE

It was necessary to provide in the freezing tanks some means of holding the cans in a vertical position against the rapid circulation. This was accomplished by the use of tapered blocks bolted to the sills for holding to tops of the cans, a 1⅝ x 3¼ x 3½-in. yellow-pine strip located on the tank floor between the cans to prevent the bottoms from moving, and guide rod ⅝ in. in diameter bolted to the tapered block. The lower end of the rod is forked and is fastened to the 1⅝-in. strip by drive screws. The rod and coils serve as guides while the cans are being filled.

A crane designed to handle eighteen 400-lb. blocks of ice at one time is one of the outstanding features of the installation. It is of the pneumatic type and motor-propelled. Two 12-in. x 8-ft. cylinders are located, one on either side of the channel-iron frame, each cylinder handling nine cans, as shown in Fig. 7. The round rings between the clevises on the can dog and the clevis on the tee-bar were desiged to hold the cans straight for entering the dumps and at the same time allow the can dog free movement so that it could be connected easily to the can.

In the past 16- and 18-block cranes have failed owing to the fact that, when a whole row of ice was pulled, the brine would be lowered below the water in the cans. This would seriously affect the freezing rate and leave a large cup in the top of the block. In the present case the special floor design and the extra-long cans solve this problem, as three rows, or 54 blocks, can be pulled out without lowering the brine below the water level in the cans.

As shown in Fig. 8, the ice dumps, eighteen in number, are located at one end of the tank. The sides are made of ¼-in. sheet iron with a 2-in. oak-wood back. The most interesting feature of these dumps is the spring bottoms used to protect the cans from shock, the springs serving as cushions when lowering the cans into the dumps.

The ice is transferred to a conveyor directly in front of the dumps, carried across the tankroom and automatically transferred to a retarding conveyor which delivers the ice to the storage rooms below. The two conveyors are timed so that the ice on the cross conveyor is transferred first behind a shoe on the retarding conveyor, which in turn holds the cake of ice back until it is delivered to the storage room.

Table I gives a fair indication of the performance of the new tank, and these data may be compared to the results obtained with the older tanks, reproduced in Table II. In the latter a heat transfer per degree temperature difference per square foot per hour of 25.8 was considered excellent, as it was above results usually obtained. The

TABLE I. PERFORMANCE OF THE NEW TANK

Number of 400-lb. cans	856
Tons of ice per day	110
Average can allowance per ton	7.7
Lineal feet of 1¼-in. pipe	28,370
Lineal feet of 1¼-in. pipe per ton of ice	257
Average suction pressure, lb	23.5
Average brine temperature, deg. F	13.5
Temperature corresponding to suction pressure, deg. F	10
Temperature difference, deg. F	3.5
Surface external pipe, sq.ft	12,331
Tons refrigeration in 24 hours	144
B.t.u. water cooling and freezing	38,720,000
B.t.u. losses tank covers, sidewalls, air for agitation	2,744,000
Total B.t.u	41 464,000
B.t.u. per square feet external pipe surface per hour	140
K-heat transmitted per degree temperature difference per square feet per hour	40

TABLE II. PERFORMANCE OF OLDER TANKS

Number of cans, 400 lb	1,818
Tons of ice pr day	238
Average can allowance per ton	7.6
Lineal feet of 1¼-in. pipe	57,000
Lineal feet of 1¼-in. pipe per ton of ice	239
Average suction pressure, lb	20.5
Average brine temperature, deg. F	12
Temperature corresponding to suction pressure, deg. F	7
Temperature difference, deg. F	5
Surface external pipe, sq.ft	24,800
Tons refrigeration in 24 hours	266.9
B.t.u. per 24 hours ice cooling and freezing	76,892,000
B.t.u. per square foot per hour	129
K-heat transmitted per deg. temperature difference per square foot per hour	25.8

40-B.t.u. heat transfer of the new tank is nearly 60 per cent better and must be taken as a remarkable performance.

The design throughout was by company engineers, Messrs. Ormsby and Gass being responsible. R. H. Tait, of the consulting engineering firm of Tait, Nordmeyer Engineering Co., was retained as an expert to pass upon the design of the flooded coils, accumulator, etc., since many features were included that were not of current practice in refrigerating work.

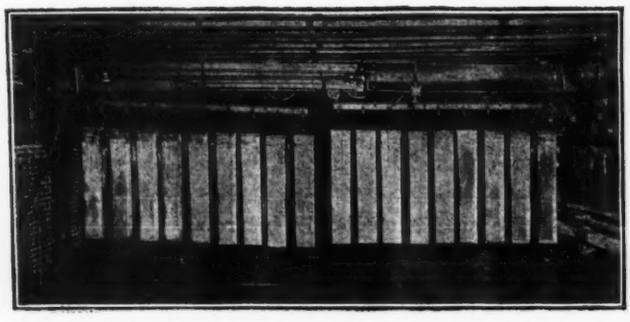


FIG. 7. MOTOR-PROPELLED PNEUMATIC CRANE CARRYING EIGHTEEN 400-LB. BLOCKS

FIG. 8. EIGHTEEN-CAN ICE DUMPS WITH SPRING BOTTOMS

Eliminating Waste To Reduce Power-Plant Costs

By Paul R. Duffey

One of a number of power plants under my supervision was showing month by month a gradual increase in operating costs. When these increases were analyzed, it was found that additional load on the plant was partly responsible. Not being satisfied that this was the entire cause, a further check showed that the plant in general was so run down and badly located that unless it was changed and necessary repairs made, nothing could be expected but a continuation in the rising costs each month.

Relocating the Boilers

In order to keep the plant in operation while relocating the boilers, it was decided to put in a continuous ashpit to accommodate four locomotive-type boilers spaced four feet apart, allowing sufficient room between the boilers to make repairs to staybolts, etc. The pit completed, a new 125-hp. boiler was set and temporarily connected to the steam main. This boiler, after being fired up, permitted cutting two of the old boilers out of service and relocating them over the new pit. A fourth unit was installed, and after this work was completed and all boilers temporarily connected to the old steam header, the boiler room was built up around the boilers and over the old boiler room, which was later torn down.

The new boiler room is of wooden construction, the framing being covered with corrugated galvanized iron siding. The ends are provided with windows extending across the entire length; windows are placed in the side next to the coal bunker and firing aisle, thus affording plenty of natural light and a cheerful place in which to work. The roof is made up of three-ply roofing and slag finish. A space four feet square was provided around each stack where it comes through the roof of the building. These openings are covered with steel plates securely held to place, thus giving protection to the roof and building against fire and weather. A concrete floor and steel plate along the firing aisle add to the cleanliness of the plant as well as to the convenience of the operator.

Special attention was given to locating the boilers in relation to the fuel supply, and it has been so arranged that the fireman does not have to take any unnecessary steps to reach the fuel, which is unloaded from the cars in quantity against the coal gates six feet from the fire-doors of the boilers. The coal bunker has a capacity of 200 tons, which can be readily replenished with the clamshell crane used in other parts of the plant.

Feed-Water Heater and Feed Pump Installed

Previous to relocating the boilers the feed water was obtained directly from the general service tank and handled to the boilers through injectors at a temperature of 70 deg. F. In the new location an old abandoned closed feed-water heater was put in good condition and a suitable feed pump secured from another plant where it had become obsolete. These were installed and the water, instead of being pumped directly from the supply tank, is taken from a new concrete sump basin into which is run the overflow from the water jackets of three air compressors and coolers; this water was formerly wasted. It has been found that no makeup water is needed, as there is still a slight excess on warm days, when it is necessary to have a good supply of jacket and cooling water. Exhaust steam for the heater has been secured by piping the exhausts from the supply pump, mill engines and air compressors into a common header discharging through the heater to the atmosphere. There has also been provided the usual bypass arrangement for cutting the heater out at any time for repairs. The temperature of the feed water under the new arrangement shows an average of 180 deg., or a rise of 115 deg., making an effective fuel saving of more than 10 per cent. Besides hot feed water, there is also a supply of hot water for filling dead boilers which can be brought up to the steaming point with very little fuel waste. Sufficient exhaust steam is available for heating the wood mill and offices, live steam being used formerly in this service.

A new and substantial steam header has been run to all boilers and plant machinery served from it. Steam and hot-water lines, including exhaust-steam line, feed-water heater and boilers, have been properly insulated with sectional covering and lagging, making an additional saving in fuel of 10 per cent.

Engines and Compressors Overhauled

All engines and air compressors have been thoroughly overhauled and put in first-class running condition. A concrete floor, well drained, was laid around all such equipment, which can be kept in a clean condition, and the man in charge has already shown that he is interested in doing better work under good working conditions. All air lines were gone over for leaks, the valves and cocks repaired, and a new discharge line common for all compressors has been provided to the main storage reservoirs which has suitable oversize valves from each compressor discharge to the main. All drains, traps and miscellaneous equipment have been put in good condition, with the results shown in the table. A master gage-board containing gages showing steam pressure, air pressure and feed-water pressure, as well as a duplex recording gage for air and steam pressures, has been added as a further incentive for the operator to produce good results.

MONTHLY OPERATING DATA

Last—Under Old Arrangement			Present New Arrangement	
Fireman	4@ $137.84	$551.36	3@$137.84	$413.52
Ash man	1@ 115.20	115.20	None	.....
Coal pans	2@ 115.20	230.40	None	.....
Fuel	300 tons @ 5.15	1,545.00	170 tons @ 5.15	$875.50
Water	estimated	35.00	No charge	.....
Oils, etc.		50.00		30.00
		2,526.96		$1,319.02
		1,319.02		
Saving per month		$1,207.94		

Saving, year, $14,495.28. The cost of the project was $3,500.00 and it paid for itself in three months.

Semi-Diesel and Hot-Bulb Engine Suggestions

On starting the engine, do not inject too much fuel oil. Two strokes of the hand lever should be sufficient. If an excessive amount of oil is used, there is great danger of blowing the cylinder-head joint.

In old engines where the usual copper gasket fails to keep the head joint tight, try using asbestos wicking braided into a rope. This should be soaked in salt water and then covered with graphite and oil before using.

In installations where the starting torch is fitted with a heating coil, small carbon particles will choke the coil; a spare torch should be always on hand. The coil can be cleaned in lye water and then blown out with air.

The World's Largest Boilers

THE eight enormous boilers that are being installed at the Ford Plant at River Rouge, Mich., are the largest of their kind and are part of the first really large power plants in the United States to use pulverized fuel. One of these boilers is already in successful operation.

An idea of the great size of the installation may be gained from the picture, which shows eight Ford cars lined up inside one of the furnaces. There is plenty of room, as the furnace measures 23 x 25 ft. and is 55 ft. in height. The boilers, which are being made by George T. Ladd Co., Pittsburgh, Pa., are of the water-tube type and have an effective heating surface of 26,470 sq. ft. Each one has two lower drums, two upper drums and one steam drum. Connecting the upper and lower drums are 1,467 tubes, 3¼ in. in diameter and having an average length of 20 ft. 6 in. Placed end to end they would extend a distance of six miles.

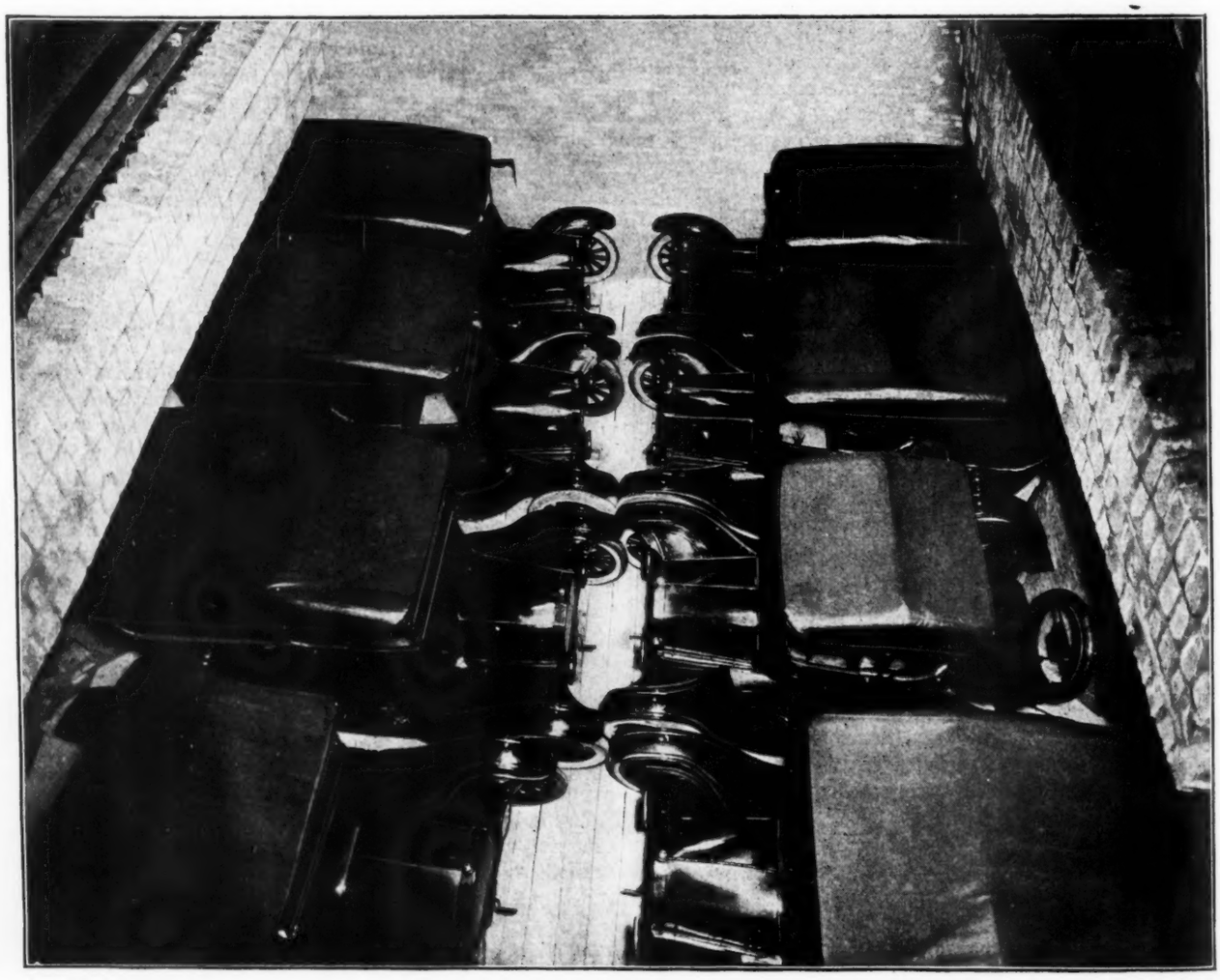
Pulverized coal and blast-furnace gas will be burned at the same time by firing the coal vertically from the top and injecting the gas horizontally through the side. The coal flame and the gas flame will unite at the proper point to give the greatest efficiency. It is planned to operate the boilers in the day-time at about 250 per cent of the rated capacity, although continuous operation at about 400 per cent will be possible.

It is estimated that 1,000 tons of coal will be consumed daily. From the time this coal leaves the Ford mines in West Virginia and Kentucky until it is carried away as ashes, it never is handled manually. All the operations are done mechanically—dumping, pulverizing, carrying to the bins, stoking, even to carrying the ashes away in small dummy cars.

Economizers will not be installed until some time in the future when it may be deemed advisable, but considerable attention has been paid to the superheater units. These are located in the first pass of the boiler, where they are protected by the boiler tubes.

There are many other interesting features about this plant; it is in almost every way a bold departure from established practice. It will be the first combined blast furnace, steel mill and foundry in the world, and will cover about 23 acres. It is designed so as to make possible the pouring of castings with uncooled metal which has come directly from the blast furnaces, a step never before attempted.

Power plans to publish at an early date a description of the power plant of this new works and will include more details of these boilers.



EIGHT FORD CARS INSIDE THE FURNACE

EDITORIALS

The Boiler Code and Cheap Boilers

THERE has recently developed a wave of agitation against the A. S. M. E. Boiler Code by builders and users of boilers, usually of the portable type, which do not comply with its requirements.

In order to judge the conditions intelligently, one should understand that the Boiler Code is a collection of rules for the design, construction and equipment of boilers, and of specifications for the material of which they should be composed in order that they may be safe.

These rules and specifications are not unnecessarily restrictive, designed to produce a boiler of superlative quality which only specially equipped shops can produce. The specifications are almost word for word those of the American Society for Testing Materials, the highest authority upon the qualities which materials should possess for given purposes. The rules for design represent the best thought of the world's best experts who have made the construction and failure of boilers a study in foreign countries as well as in our own. In the process of its formulation exhaustive hearings were held in which boiler users, insurance companies, manufacturers of materials and accessories, boiler manufacturers and in fact every interested party appeared and discussed the bearing of the proposed rulings upon their interests. The Boiler Code Committee itself comprises representatives of most of these classes. The result is a formula for a boiler of high grade but without any frills, which does not exclude any boiler that is reasonably safe nor condemn types or practices that are not admittedly bad. The American Society of Mechanical Engineers offers it as a standard, a boiler built to which will be free from defects that have been found to be productive of explosion.

Having done this, the society concerns itself only with the interpretation and betterment of the Code. It has no power to impress the Code upon industry, no right to insist that new boilers be built to its standard, and especially no concern with boilers already built.

True, the Code has a short section relating to existing installations, but it is a dead letter. It consists for the most part of a reiteration of the rules of the main section and for the rest of provisions which had better be left to the judgment of the authorities of the states or municipalities adopting the Code. In its inclusion of this feature it follows the Massachusetts Boiler Rules upon which the code was largely modeled, which feature, while pertinent and necessary in the rules governing the administration of a state boiler department, is out of place in the code of a society competent to define what a boiler ought to be, but which is not called upon to decide what ought to be done with a lot of boilers already in use which are not up to its standard.

Gradually, the legislatures of the several states are awakening to the importance of industrial accidents and are establishing industrial commissions, departments of safety, factory-inspection bureaus, etcetera. Some of the states have made a separate case of the steam boiler and under some of their safety commissions have instituted divisions of boiler inspection. In fifteen of the states and in a number of cities the boards or other bodies having the regulation of boilers in charge have adopted the A. S. M. E. Code boiler as their standard, and in the interest of uniformity it is hoped that the others will do so. Usually, this standard is applied only to new installations, existing boilers being so dealt with as to allow them to serve out their term of usefulness without becoming too much of a menace to the public safety.

If all the states would thus adopt and enforce the Code for new installations, all would be simple. The old and inferior boilers would be gradually worked out, boiler practice would be standardized, the boilermaker would simply have to build a boiler to the Code to have it universally acceptable, the customer would know what he was getting, and the danger of explosion would be confined to faulty operation. But there are those who insist upon building a cheap and inferior grade of boiler, claiming that it is good enough for the purposes for which it is designed. These are mostly of the portable type for use out in the open country, and if they blow up will, it is claimed, kill only a few farmers, lumbermen or oil-well drillers anyway. The curious thing is that the users of these boilers are as persistent and aggressive in their insistence upon their right to use them as are the builders in their insistence upon their right to make them, and between them they have enough influence with the legislators of the majority of the states to prevent them from adopting measures for regulating the construction and use of boilers or, if such measures are adopted, to get themselves, as a class, exempted from their provisions.

Such pressure and such tactics will delay for a time the nation-wide adoption of the Boiler Code, but gradually the law makers will recognize that the use of steam boilers must be regulated, and when legislation providing for such regulation is passed, the inspectors appointed under it will be increasingly likely to adopt the A. S. M. E. Code boiler as the standard to which they will require new boilers to conform before they can be operated, at least in factories and centers of population.

The treatment of existing installations must not be so drastic as to put out of commission a lot of boilers which, while not so immune from explosion as the Code boiler, have a fair chance, with good supervision, to put in yet a few years of usefulness. This treatment will require tact on the part of the Board and vigilance and skill on the part of the inspectors. These old boilers will work themselves off in a generation. As a matter of expediency, legislators, in adopting boiler-inspection laws and inspectors in enforcing them may have to tolerate for a time the risk of murder and suicide upon

the part of the adherents of the cheap boiler for use in sparsely settled districts in order to secure protection for the public in more congested parts. But the matter will eventually work itself out. If the cheaper boilers do not explode, if the provisions of the Code by which they are disqualified are proven to be uncalled for and unnecessary to safety, the Code will have to be modified in these respects. If, on the other hand, they do continue to explode and it can be shown that their explosion is due to the failure of their makers or users to comply with the requirements of a safe boiler as defined by this board of recognized authorities, any court will ascribe their explosion to willful negligence, and the damages and opprobrium may be more onerous than compliance with approved practice.

Power-Plant Accounting

IN TOO many manufacturing plants the power and heating requirements are considered "non-productive" departments and insufficient attention is given to either economical operation or betterments. Coal is purchased and stored with only the most cursory record of the tally and expenditure. In a modern plant or machine shop a tenpenny nail could not be obtained without the proper requisition passing through the accounting channels, notwithstanding that the cost of this particular record may be greater than the article involved.

Contrast this with the methods of handling fuel. In many cases thousands of tons of coal are purchased, piled in the yard and used for heating and power generation with no check except the invoice and car weights from the coal or railroad company. No record of its distribution or accounting is attempted. A truck could be loaded and large amounts diverted to personal uses with no fear of discovery unless the theft was actually observed, and such instances are not unknown.

This is one of the inherent causes of power-plant wastes and also the reason why so many suggested improvements in operation are received with skepticism. As the management has not the faintest idea where the fuel is being used or how economically, there is no basis by which to judge changes or to ascertain whether a saving is possible. This lack of accounting in large manufacturing plants is more widespread than is generally realized.

Plant operators having no records or methods of demonstrating facts are sadly handicapped when trying to improve conditions. It is a function of the executive to probe the suggestions offered and determine the facts. Complete records in the power plant and a little money spent for proper accounting would not only solve his difficulty, but automatically bring about economy in operation by showing up shortages and departure from standard conditions. In operating results the executive would have a basis of comparison—he would know what to demand when an addition or new plant was to be built and after installation he would be able to check what had been received.

With initial investment averaging from one hundred to one hundred and fifty dollars per kilowatt of generating capacity and coal and labor bills running to extremes, it would seem that the comparatively few dollars required for power-plant accounting would be warranted many times over. If every department received monthly bills for power and heat the same as for raw products and labor, it would create a demand for accurate accounting and in doing so insure more economical results.

The introduction of a few miscellaneous meters, even if they are read regularly, and the compilation of fuel costs monthly or yearly are of little use. Such practice may be likened to maintaining a ledger and neglecting part of the entries on one side or the other. Accounting records should be kept so that at any time the manufactured products, such as steam for heating and processing, hot water and power, can be exactly balanced against all loss and expense, including the cost and quantity of the particular fuel purchased and used.

In charging departments a profit should be added to cover upkeep and betterments. In other words, the power plant should be on a separate basis of its own and made to stand on its own feet. Each finished manufactured product and each department should bear its portion of the expense. Unnecessary use of power by overmotoring and other wastes would be reflected in the costs of the offending departments.

Compiling Useful Data

WHERE can the information be found to solve such and such a problem? Where did I see this information in some technical paper or book? These are questions that most of us frequently have occasion to ponder over, and we spend much time in searching, all because our memory fails us at an inopportune time. The amount of valuable data published in technical books and magazines for engineers is beyond comprehension, but that there is still a great void that has not been filled, is clearly evident from the many inquiries we receive each week. The majority of these questions are not on subjects on which there is a lack of reliable data, but on the very questions discussed from week to week in *Power*. Frequently, the answers to the questions are given by sending those asking for information pages taken from a previous issue containing an article dealing comprehensively with the subject.

All this leads to the suggestion, which has frequently been made before, that *Power* readers should have some system of making available, when needed, the information published each week pertinent to their particular problems. One of the simplest and easiest ways of doing this is to file the copies away and at the end of each six months file the index, which is supplied gratis, either with the copies or in a binder. Then, when any question arises on which information is desired, it can be easily determined what has been published in *Power* on this subject. Another method is to keep a clipping file or scrapbook and file each week the articles which the reader thinks may be of service to him, under subject heads. Some of the best handbooks, so far as the individual owner is concerned, are of the home-made variety and have been compiled by arranging useful data in available form, as it comes to hand. It makes little difference how much useful information may be stored in books and magazines, so long as the possessor of these does not know when and how to call it to his assistance when needed. Information, to be of real service, must be in one of two places—either in the individual head or in such published form as to be readily accessible when needed.

The Standard Oil Company of Indiana, with an outstanding capital of thirty million dollars, has a surplus of one hundred and five million dollars and has declared a stock dividend of one hundred and fifty per cent.

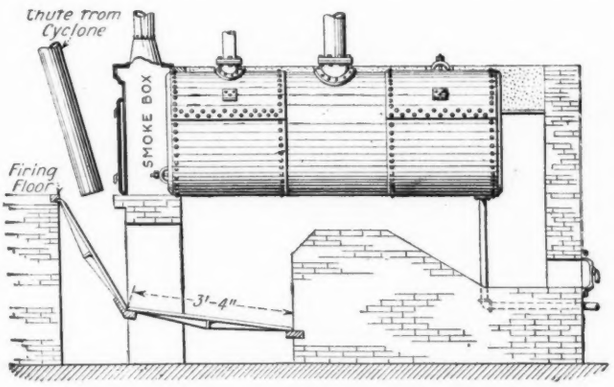
Gasoline today thirty-five cents!

CORRESPONDENCE

How Can Shavings Be Burned With Coal?

In a plant with which I am acquainted enough shavings and wood cuttings are produced to supply four 16-ft. x 72-in. return-tubular boilers. There are other boilers using coal. The furnaces by some stretch of the imagination have been called dutch ovens, but how nearly they resemble the dutch oven may be judged from the accompanying sketch. The opening through which fuel is fed is about 4 ft. 6 in. by 8 in. The shavings are fed direct from the cyclone shavings collector, and the wood cuttings, which measure up to four feet in length, are dumped from barrows into the opening and then shoved back by pokers.

Formerly, the custom was to let the opening fill up with shavings, then shove them back with the poker.



FURNACE FOR BURNING SHAVINGS AND COAL

The result was that carbon monoxide was formed, which invariably caught fire in the smoke-box from in-leakage of air. It is said that flame has been seen at the top of the chimney.

The remedy for this kind of combustion was to keep an opening at each end of the furnace for the admission of air. With cuttings this was not necessary, as sufficient air could enter through the voids unless these were filled with shavings. The horizontal grates are 40 in. long with 30 per cent air space, the spaces being $\frac{3}{4}$ in. wide. The result with this width of air space is not satisfactory as the grates choke too easily with ashes. Last summer one of the furnaces was fitted with grates 48 in. long and over 38.5 per cent air space, the spaces being $\frac{5}{8}$ in. wide. The result was a great improvement. The plant is equipped with an automatic damper, and the smoke is decidedly worse when it is closed to the limit for which it is set.

On account of lack of floor space the coal is burned under certain boilers and the wood and shavings under others, but I believe it is better to keep the fuels separate anyway.

In regard to leaking tubes, the present engineer's place of worship from Sunday morning to Sunday evening was in the combustion chambers of the wood-burning boilers rolling and beading tubes, but as the boilers were exceedingly dirty the leaking cannot with certainty be said to have been due to the fuel because the tubes of the coal burners leaked also.

The compound used was a well-known water treatment. By careful attention to the compound and the use of a tube cleaner, the boilers reached a condition described as "very good." But there was still too much tube trouble. Early last summer a so-called metal treatment was used and leakage was greatly reduced but whether as a coincidence or as a result it is as yet impossible to say.

Next spring we expect to begin alterations that will include a real dutch-oven furnace and a type of boiler that will give sufficient floor space for it, and my intention is to feed the shavings through the roof of the furnace and the cuttings, some of which are heavy, at the front end onto inclined grates considerably flatter than they are at present so as to give them a slide into the furnace, and also to have an adjustable shutter to regulate the air admitted to the furnace.

Toronto, Ont., Canada. R. McLAREN.

Boiler Drum Pitted

In the Oct. 26 issue of *Power*, page 675, Charles W. Carter, Jr., asks for the opinions of readers regarding the pressure on the different drums of a water-tube boiler.

I believe that the pressure on the six drums is equal so far as steam pressure is concerned, but that there must be more pressure on the lower drums due to the water in the boiler. This extra pressure will be approximately one pound per square inch for each twenty-eight inches in height of the body of water.

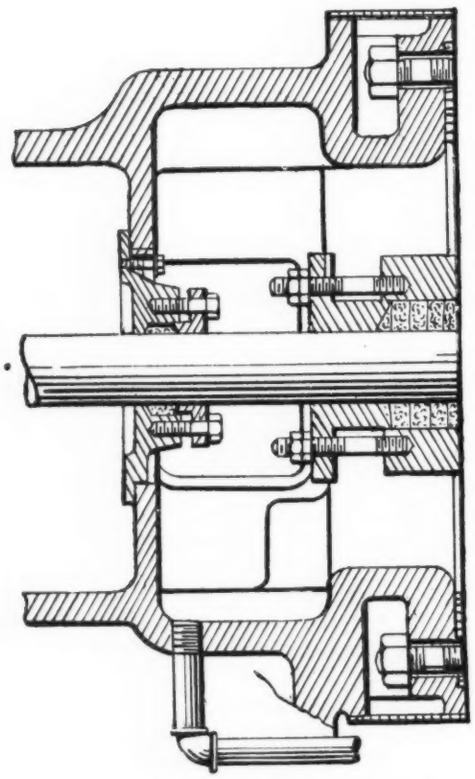
Therefore, if it is seven feet from the bottom of the lowest drum to the water line in the boiler, there must be about three pounds per square inch more pressure on the bottom of the lower drum than at the water line. There is no other reason why there should be a difference in pressure on any part of a water-tube boiler.

I think Mr. Carter's theory as to the cause of pitting is correct. L. M. REED.

Webster, Mass.

Prevented Water Getting Into Crank Case

A self-oiling engine gave trouble from water getting into the crankcase from the stuffing box and causing the oil to emulsify. Almost every kind of oil was used without results. At the end of the frame was a cast-iron partition with a 5-in. hole through it. This was covered with a sheet-brass plate through which the rod ran. A drain hole in the cast-iron partition let the water, which



LOCATION OF AUXILIARY STUFFING BOX

dripped out of the stuffing box, run into the crankcase. A stuffing box and gland was made and bolted to the partition, as shown in the illustration, and the drain was stopped up with a metal cement. A ½-in. pipe connection was made through the side of the frame into the space between the stuffing boxes to drain out the water. Since this has been done the oil remains perfectly clear.

Canton, Miss. JOHN T. SHARP.

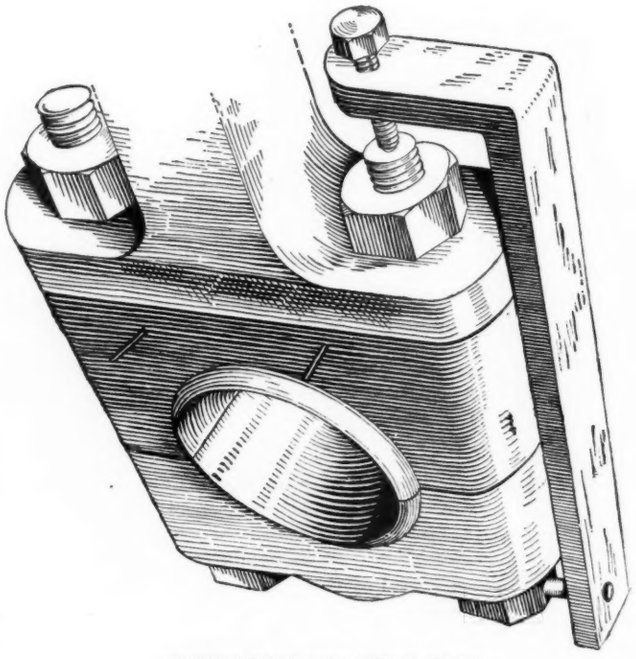
Detecting Elongation of Connecting-Rod Bolts

Seemingly, very little attention is paid by operators of Diesel and semi-Diesel engines to the question of elongation of the connecting-rod bearing bolts. In tightening up the nuts, often the bolts are severely stressed before the engine is put in service. Frequently the cranking bearing is allowed to run entirely too slack. The inertia of the pistons as the crank passes dead center is sufficient, in view of the play in the bearing, to stretch the bolt beyond its elastic limit. The bolt then fails. This puts all the stress on the remaining bolt, which either bends, opening up the brass, or breaks. When such an accident occurs, the connecting rod and piston come loose, wrecking the engine.

Several such wrecks have occurred during the last few months. Undoubtedly, one or more have been due to excessive slackness in the crank-pin bearing. The engineer has no reasonable excuse to offer for this class of accidents. The pounding of the bearing should indicate to a trained ear that the engine requires immediate adjustment. The fractured bolts resulting from elongation occurring when the nuts were being tightened are hardly blameable to the operator, although he should use judgment as to the manner of tightening. Elongation of bolts resulting from loose bearing or undue tightening does not take place immediately; it is gradual, and for that reason some device for detecting the elongation before it reaches the danger point should be provided.

The little contrivance illustrated, which might well be called an extensometer, was made by a Diesel engineer and will detect alterations of less than one-half of a thousandth of an inch. On the two Diesel engines in the plant, a hole was drilled in the side of the connecting-rod bolt heads and reamed to size. A tool-steel bar was bent as shown, and was threaded at one end for an adjustment screw. The other end was also fitted with a pin that fitted the hole in the bolt head. The ends of the bolts were ground until all were of equal length, the variation in length being less than 0.001 in. The adjusting screw was then set to barely touch a 0.01 brass plate when placed on the end of the bolt. In tightening up, a wrench and heavy hammer were used, but the bolt was never drawn up enough to elongate.

Each time the inspection doors on the crankcase were opened, the bolts were measured. If the clearance be-



CONNECTING-ROD BOLT GAGE

tween bolt and gage was less than 0.008, it was assumed that the bolt had stretched and it was removed. Only one defective bolt was ever detected. This particular one, however, showed a decided lengthening, and on investigation a fracture which extended half through the bolt was discovered.

E. LONG.

Dallas, Tex.

Does a License Law Help?

In an article in the issue of Oct. 12, page 591, "Does a License Law Help?" the author severely criticises license laws and is of the opinion that such are practically of no use or benefit to anyone. If it were not for license laws one can imagine the undesirables that would be found running engines, not knowing one part from another, and being obliged, when a breakdown occurred, to call up a near-by machine shop and get a mechanic to do the necessary repairs.

If we had a uniform graded license law, there would be more chance for advancement and engineers would make it a point to study and get the first-class grade, as that position would undoubtedly pay the most wages.

I do not say that an engineer must have a college education, although he would be better off if he had, but I do maintain that he should thoroughly understand the mechanism of every machine under his supervision.

I say, pass laws requiring licenses and make non-licensed engineers get in line and show whether they are capable or not; do not let every Tom, Dick and Harry come along and be promoted to engineers in two days' time.

CHARLES W. CARTER, JR.

Olean, N. Y.

Regarding Mr. Shaw's communication "Does a License Law Help?" there are two sides to every question and I would like to have the readers of *Power* hear the other side of this one.

I am glad that Mr. Shaw is not opposed to license laws. Neither am I. In fact, I am strongly in favor of them. I will not attempt to defend the license laws of other states or cities, but will take up the question from the viewpoint of a licensed engineer in Massachusetts.

I know that the license laws here do help the engineer, increasing his pay and enlarging his knowledge of the proper operation of the steam plant. As a matter of fact the operating engineers in this state receive considerably higher wages than those in adjoining states where there are no license laws. As to increased knowledge there is no greater incentive for a fireman or an engineer to increase his knowledge than for him to tackle the steam-power plant game in this state. This I state as a result of my own experience. I do not doubt what Mr. Shaw says in regard to the vast number of engineers who carry different forms of licenses and operate in other states, but I believe that the percentage of those who operate on stolen licenses, etc., is but a small fraction of one per cent of the whole number of engineers employed, therefore I do not think that part of the argument amounts to very much.

I believe that the Alabama engineer of whom Mr. Shaw speaks is an exception the rule. I have met and worked with quite a number of engineers whose education was about as limited as this one, and I have found that, in the operation of their own plants, they were pretty good, but when it came to the knowledge of the underlying principles that govern the care and operation of any steam plant their ideas were very limited, which is a natural consequence.

I do not claim that the possession of a license indicates that a man is infallible as an engineer, but I do claim that one who has obtained a first-class Massachusetts engineer's license within the last five years has proved himself to be a practical man and to be possessed of a sufficient knowledge of the construction of steam boilers and of the vital facts and principles that govern the care and operation of a steam plant to make him a pretty safe man to place in charge of one.

As to the case cited by R. G. Summers, in the Sept. 14 issue, it is my candid opinion that a real engineer, whether licensed or not, would have been able to show his employer where he was in error.

The engineers of the country—the real engineers—want a license law and they are going to get it; perhaps not all in the same form as those of this state, some not so good, some perhaps better. As to a Federal license law, no such thing can exist owing to the sovereignty of the individual states, but if 55 per cent of the engineers in the different states knew the actual benefit to be derived through the enactment of sound license laws and were not afraid that if such laws were enacted their knowledge would not measure up to the standard required, there would be license laws passed in the various states as soon as their legislatures convened.

It is true that the holder of a license may be no better as an engineer than the one who does not hold one, but the average engineer who holds a license is certainly more capable of approaching his employer with suggestions owing to the very fact that he had to study, to dig down to the very bottom of things to obtain enough knowledge to pass his examination, and in so doing he acquired more confidence and is better able to talk with his employer upon the subjects which arise.

Mr. Shaw states that a man's competency to operate a plant could easily be found out as soon as the man began work if his employer knew anything about it at all. I take it from that he means if his employer knew anything about steam plants. I would like to ask what he considers a fair percentage of the employers of engineers throughout the country who know even the simplest rudiments of the care and maintenance of a steam plant? The average employer is not to be compared with the average official who sits on the examining board of engineers in this state. Every one of these men, I think, has been a practical operating engineer and has had to pass a rigid examination to obtain the position he holds and is possessed of a considerable amount of very useful knowledge of technical things.

Then, where does the average employer fit when it comes to determining a man's ability as an engineer as compared with the judgment of three such men as comprise a board of examiners for a second or first-class engineer's license in Massachusetts? Not only do they judge a man's ability by what he can show them during his examination, but a man begins with them as a rule as an applicant for a second-class fireman's license, and they follow him along as he obtains a higher-grade license, in his plant, in his daily work. They visit those plants which are in their particular territory, and if a man in a certain plant has applied for a license they look him up, see what his reputation is as a fireman or as an engineer and talk with him on the job.

Things have changed since Brother Shaw obtained his first-class license 25 years ago. By no means do I intend to infer by this that he is not in reality a first-class engineer, but I fear he is out of step with the times as regards Massachusetts license laws. Twenty-five years ago we were examined by but one man, today by three men. A man who had sufficient knowledge to obtain a first-class license in 1895 would do mighty well now to obtain a second, and the laws are getting more strict each year; and as they become so there can be but one effect—it must raise the standard of the licensed engineer.

I can see that the engineers of the country would be better off with a license law than they are at the present time, and I also can see that the employers would be benefited; if this were not so, the claim that education is beneficial would be without foundation, and if it pleases one any better to call our license law a compulsory-education law, so be it, for that is just what it is.

They are learning more and more to appreciate an engineer who is educated along his line, and are getting to realize that while the steam plant may be a necessary evil, it is something that does need skilled attention. Things are shaping themselves very fast in favor of license laws in every state where there is at least a normal amount of industry, and the high price of coal is not the least factor which tends to help, by any means. Let us have license laws; if each engineer helps himself, a license law will help him.

We realize that there will be a small percentage of men who are unable, due to limited education, to acquire a high-grade license, and it is to be regretted, for in many cases it is not their fault; but a few sacrifices must be made for the good of the whole.

Webster, Mass. L. M. REED.

The license-law question should be dealt with from all sides. It is admitted that a license is of little value as regards a man's ability, as there are men operating who are not licensed and are receiving salaries equal to that of the licensed man who has spent years in study and work to obtain a license. The licensed engineer is entitled to and should receive a much higher rating than the non-license man.

The license should be graded into three classes. The first-class man should be capable of assuming the chief duties of operating which, in the general run of the plants, are left to the watch engineer.

The second-class man should be capable of performing the duties of assistant chief operator, and in the course of time he can advance to chief engineer. He would have plenty of time to study the plant and to pick up what he could relating to combustion, an important factor in the engineering of today.

The watch engineer should hold not less than a third-class license, but there are watch engineers who have first- and second-class licenses.

A license does not help a fireman make steam, but it does incidentally protect both life and property. With a licensed fireman and water tender the manager knows that they are qualified to perform their duties. There should be two classes of firemen's license and there should be a fireman and a fireman's helper. The fireman should hold a first-class and the helper a second-class license. The water tender should be in a class by himself. He should be a man that has started as a fireman or fireman's helper and has worked his way up.

The water tender who cannot speak English should not be permitted to tend water in any plant. I recall an instance where the engineer placed a log board in the boiler room and instructed each man to fill in at various places when leaving his shift. When the engineer came back, there were no entries on the log sheet, and upon investigating he found that none of the men could read or write English. Would they be good men to have on the job in case of accident?

I was recently called upon by the manager of a mining plant to go over his plant with him. Each boiler was provided with a U-tube draft gage and they were being operated under natural draft. Upon investigating, only one gage was found to be in working order. Three were broken and the piping on four was clogged.

Had the plant been in charge of a licensed engineer, he would not have allowed the plant to get in this condition. I will admit, however, that I have visited plants where unlicensed men were in charge and found things in just as good condition as in the license-operated plant, but there are exceptions to all cases.

I trust that the time will soon come when we can have a universal license law and that every individual that is connected in any way with power-plant operation will be a licensed man. R. M. JENNINGS.

Latrobe, Pa.

Behavior of a Semi-Diesel Oil Engine

In *Power* of Oct. 26, page 674, some troubles of a semi-Diesel oil engine are described and a solution is asked. One of the most remarkable things about this type of engine is the extremely meager amount of information published or otherwise obtainable.

The seizing and sticking of the piston may occur from a faulty cooling system or poor bearing of piston on cylinder walls. The cooling system should be sufficient to cool the cylinders "stone cold" at the maximum load the engine will pull. For the volume of water passing through jackets must increase as the load increases; or in other words, the temperature must be lowered until the piston stops pounding from heat. The piston should show a full bearing at full load and no high spots or other distortions. This may be remedied thus: The engine should be run at its maximum load and the piston carefully watched for pounding or groan, and removed at first sign of it, and all high spots filed down. This process should be repeated until the engine pulls its maximum load without any sticking or seizing.

The cracking of exhaust and inlet port bridges is caused by unequal expansion when solid bridges are used between exhaust ports, and clogged circulation passages when water-cooled bridges are used. Solid inlet-port bridges do not break because they are not exposed to heat, but the exhaust-port bridges should be water-cooled to prevent cracking and the circulating water should pass these ports first before cooling elsewhere.

The fuel system requires careful attention, particularly the straining of the fuel of all grit and foreign matter. If this is neglected, all manner of annoyances will occur, for it breaks and misdirects the spray from the fuel nozzles. The fuel nozzles should be checked for spray at intervals. This is very important especially where the spray is directed against some special igniting surface.

If an engine is a four-stroke-cycle type, there are other freaks. I remember seeing such an engine tested. It pulled its rated power for one hour, the next hour only ¾ load, the next hour only ½ or ¼ load, and finally stopped altogether. Nobody could locate the trouble, and design and engine were scrapped. Three years afterward in another factory, I ran across an exactly similar circumstance. We were all about to throw up our hands when one tester suggested we examine the valves, and here trouble was found—the seat had warped from heat. When this was remedied, the trouble disappeared. G. STROM.

Erie, Pa.

INQUIRIES OF GENERAL INTEREST

Carbonizing of Diesel-Engine Cylinder After Repairs—I find that the cylinders of my Diesel carbonize badly. What is the reason? I recently put in new crankpin bearing. Would this cause the trouble? J. M. C.

In putting in the new bearings, you probably failed to replace sufficient shims between box and rod end. Low compression resulted, which would produce soot or carbon.

Welding Fractured Crankshaft of Oil Engine—Can a fractured oil-engine crankshaft be welded successfully? C. B. H.

Electric welding of crankshafts has been uniformly successful. This does not mean that an inexperienced man can weld successfully. Such work should be turned over to firms who are experts in the work. If the weld is ground and polished, it is easy to determine if it is perfect.

Suspended Engine Foundation—How can a suitable foundation be provided for an engine placed on the second floor of a steel-frame building so the engine bed may be the usual height above the main floor-line? F. K.

The foundation recommended by the engine builder is for the purpose of absorbing vibrations as well as for supporting the engine, and if the building framing is strong enough to support the engine and foundation, a mass of concrete equal to that recommended by the engine builder may be suspended from the floor framing, with the upper surface of the foundation carried up to the desired level for receiving the engine.

Density of Steam—What is meant by the terms "specific volume" and "density" of steam? A. H.

The specific volume of saturated steam of any pressure is the volume in cubic feet of one pound of steam of that pressure. Density signifies heaviness or weight of a unit of volume. The density of steam usually signifies the weight in pounds per cubic foot and is the reciprocal of the specific volume. The density of dry saturated steam increases with the increase of its pressure. At atmospheric pressure or zero gage pressure, the density is 0.03732 lb. per cu.ft., and at a pressure of 100 lb. gage, or 114.7 lb. per sq.in. absolute, the density is 0.2571 lb. per cubic foot.

Electrical Input to Develop 15 Brake Horsepower—Will an electric-driven pump that requires 15 hp. when driven by a 20-hp. motor consume 20 hp. or will it only consume 15 hp.? C. D.

The actual, or brake, horsepower developed by the motor will be the number of horsepower required by the pump, regardless of the rated capacity of the motor. The amount of electric power absorbed by the motor would depend on the efficiency of the motor when developing 15 brake horsepower. A 20-hp. motor developing 15 brake horsepower would have an efficiency of about 80 per cent, requiring an electrical input of $15 \div 0.8 = 18.75$ electric horsepower, or $18.75 \times 746 = 13{,}987.5$ watts.

Use of Crude Oil as Fuel—Why is not crude petroleum used for boiler fuel? W. R. F.

Crude oil contains many highly volatile constituents that can be distilled off and have high market value in the forms of gasoline and allied distillates. The presence of these volatile constituents makes the oil more dangerous to store or handle, as combustible vapors are given off in large quantities at comparatively low temperatures and the mixtures formed with the atmosphere are highly explosive. Hence, the material generally marketed as fuel oil is a residuum left after the more volatile constituents of the crude oil have been distilled off, and it has nearly the same properties as the crude oil without giving off the dangerous vapors at so low a temperature.

Inches of Vacuum Not Determinable from Temperature—Cannot the number of inches of vacuum, or absolute pressure, of a condensing system be known from the pressure corresponding to the temperature of dry saturated steam as shown by the steam tables? J. H. C.

The temperature is not an index of the pressure because of the presence of an unknown quantity of "air." The exhaust of an engine is a mixture of water, vapor and gases, the gases being a mixture of those originally dissolved in the boiler-feed water and atmospheric air which leaks into those parts of a condensing system in which a partial vacuum is maintained. Hence, the absolute pressure within the condenser, as indicated by a vacuum gage, is that of water vapor at the pressure corresponding to the temperature, plus the pressure due to any gases present. As there always is more or less of the gases present, an actual vacuum-gage reading always shows higher absolute pressure than the pressure of saturated steam corresponding to the temperature as given in tables of properties of steam.

Computing Theoretical Mean Effective Pressure—What is the formula for obtaining the theoretical mean effective pressure of an engine, knowing the initial pressure and fraction of cutoff? D. R.

The mean forward absolute pressure per pound of initial absolute is given by the formula

$$P = (1 + \log_e R)\ (f + c) - c$$

in which

P = The mean forward pressure per pound absolute;
f = The fraction of stroke at which cutoff takes place;
c = Per cent. of clearance;
R = The actual ratio of expansion, that is $1 \div (f + c)$;
$\log_e R$ = Hyperbolic logarithm of R.

The mean forward absolute pressure per pound of the initial, multiplied by the initial absolute pressure, gives the mean absolute forward pressure. Subtracting from this the mean absolute back pressure gives the mean effective pressure.

In place of making tedious computations, values of P for different values of R, f and c may be obtained from tables, such as given on page 115 of of F. R. Low's work entitled "The Steam Engine Indicator."

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Steam Regenerators in Mine Plants Save One-Third the Coal*

By W. H. SCHACHT†

Installation of steam regenerators between mine hoisting engines and the heating load, permitting a large reduction in back pressure and utilizing the exhaust steam to better advantage, reduced coal consumption from 25,000 to 17,000 tons per year—a saving of one-third the fuel.

IN THE Lake Superior district the air indoors must be heated continuously during eight months of the year and occasionally during the remaining months. Incident with mining in this district, therefore, there is need for heating many of the buildings connected with these operations. In addition to the mine buildings—that is, shops, engine houses, offices, change houses, etc.—such public buildings as schools, library and theater, when close to the mines, are often supplied from the mine heating mains.

At the Copper Range Co.'s mines, Champion, Trimountain and Baltic, the heating surface thus supplied from the mine mains is over 50,000 sq.ft., which requires a steam consumption, at times, of 18,000 lb. per hour, or the equivalent

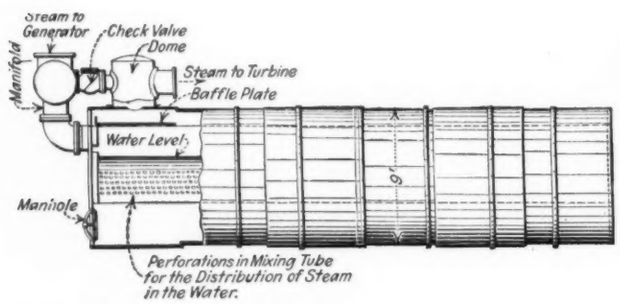


FIG. 1. TYPE OF REGENERATOR INSTALLED

of over fifty tons of coal per day were live steam used. This figure is based on a consumption of one-third pound per square foot of heating surface during the coldest weather, and provided the system is not wasting steam by blowing it to the atmosphere or into the return line on account of leaky traps, which so often is the case.

At the stamp mills the use of the exhaust from the stamps to operate low-pressure turbines has reduced the former water rate per horsepower developed by more than 50 per cent. Electric motors have replaced the many small steam engines, so that this supply of exhaust steam has been practically eliminated. The larger engines are compound, triple or quadruple expansion, condensing. The hoists, however, in all cases are simple and noncondensing and of two sizes, 24 x 60 in. and 32 x 72 in. These hoists now offer the only available supply of exhaust steam; but as the flow is intermittent and varies from extreme violence to zero, the steam so discharged cannot be satisfactorily used without some means of storage, such as is offered by a regenerator that transforms the variable flow into a constant one.

Efforts were made to use this exhaust steam for heating, without using regenerators, by having it discharge directly into the heating system, using a back-pressure valve weighted so as to provide sufficient pressure to permit the circulation of the steam through the system. The greater portion of it, however, for lack of storage capacity, escaped through the back-pressure valve to the atmosphere. The supply so obtained was not sufficient and had to be supplemented with live steam, introduced by an automatic reducing valve at a pressure usually a few pounds under that at which the relief valve was set. This meant that the hoisting engine would exhaust against a back pressure, which in cold weather and on account of poor design or condition of the system sometimes was as high as ten pounds or more, thereby reducing the efficiency of the hoist, because of the reduction of the range through which the steam used by the engine could expand.

With this reduction in efficiency there was a greater steam consumption for the engine, and although some of this additional steam was used in the heating system, most of it was discharged to the atmosphere. As a result the operation was not as profitable as feeding live steam directly into the system without the imposed back pressure on the hoist.

The condensate and non-condensable vapors from the several buildings heated were returned to the boiler house and discharged from the system by using steam-driven wet-vacuum pumps. This condensate, on account of the oil contained therein, could not be used for boiler feed and had to be wasted.

A survey showed that the steam requirements for heating for more than half of the year were equal to or in excess of that required by the hoists; further, during the coldest weather, at most of the plants, live steam would have to be supplemented, and for the remainder of the year most of the exhaust would be required. Considerable steam is used in the summer months for heating the dry or change houses, water for buildings, and feed water for the boilers. To utilize as much of the exhaust steam as possible, steam regenerators of the Rateau design were placed between the hoisting engines and the heating system.

Method of Operation

As is well known, the method of operation consists in passing an intermittent flow of steam through a closed vessel, or regenerator, in which the steam is condensed and re-evaporated. Condensation takes place when the steam is in excess of the quantity required to maintain a constant flow of outgoing steam, and re-evaporation takes place when the steam discharged into the regenerator is not sufficient to maintain this constant flow. The condensation and re-evaporation are due to interchanges of temperature between the flowing steam and a large mass of water. To keep this water in intimate contact with the steam flowing through the regenerator, the surface of contact must be as great as possible.

The regenerator is equipped with a suitable steam dome for the discharge of the regenerated steam to the heating system and with a special automatic water-level device which removes the water of condensation entrained with the exhaust steam. A relief valve controlling the maximum pressure permissible between the exhaust of the engine and the main inlet is located at a suitable point of the piping. The exhaust steam discharged into the regenerator always contains water. After passing through the water in the regenerator, the steam never contains more than a fraction of 1 per cent of moisture. This apparatus was found to be equally efficient as an oil separator. The condensate of the regenerated steam is practically free from oil and suitable, therefore, for boiler feed, which was not the case before regenerators were installed. A longitudinal section of the regenerator is shown in Fig. 1.

Some of the buildings to be heated are 2,300 ft. from the engine house and well above the elevation of the boiler house, thus offering ideal conditions for gravity return and good drainage. As a result the condensate is returned to

*Abstract of a paper presented before the Lake Superior meeting of the American Institute of Mining and Metallurgical Engineers, Inc.

†General manager, Copper Range Co., Painesdale, Mich.

the boiler house and discharged from the system (operating at 20 in. of vacuum) by means of a water seal.

In remodeling the several heating systems, estimates of the steam requirements were made and pipe sizes used that would give a pressure drop through the mains of approximately one pound. The return lines installed were also of ample size. Asbestos sponge felt one inch thick was used where the pipe lines are sheltered—that is, where they are suspended in concrete boxes—and 1½ in. thick where the pipe lines are exposed to the weather. The return lines are covered also so as to conserve the heat in the boiler feed. These coverings are protected from the weather by asphalted asbestos jackets which, when in place, are given a coat of asphalt paint.

No slip expansion joints were used, expansion being provided for by offsetting the lines 50 or 60 ft. at intervals of 500 ft. The piping is usually anchored midway between the offsets. One of the systems at the Champion mine, which has 2,300 ft. of mains in which all expansion is provided for in this manner, has not required the use of a wrench on it since it was installed, about three years ago.

These pipe lines are suspended in long slings suspended from a steel beam resting on concrete columns. The slings are free to swing from an eyebolt having a vertical thread adjustment for pipe alignment. A diagrammatic sketch of one of these installations is shown in Fig. 2. From the cylinders the exhaust is piped to the regenerator inlet, which is placed at least six feet below the cylinders to avoid drawing back water from the regenerator into the cylinders

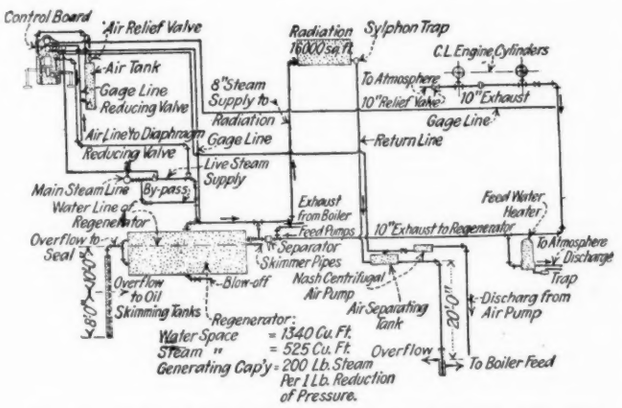


FIG. 2. DIAGRAMMATIC SKETCH OF PIPING SYSTEM

when the engine is idling or drifting, thus causing a vacuum sufficient to raise the water several feet above the level in the regenerator.

In some installations the regenerators are placed in the basement of the engine house; in others they are placed in the boiler room. An atmospheric relief valve in the exhaust line near the engine can be set to maintain any pressure desired, but it is usually set to relieve at one-half pound above atmosphere. The exhausts from the boiler-feed pumps, hoist auxiliaries and trap discharges from the hoist receivers are also piped to the regenerator. The feed-water heater is connected to the exhaust line between the engine and the regenerator, so that it gets its supply of steam from the engine or pump exhaust or draws from the regenerator when the other supply is insufficient. As the pressure in this line is below atmospheric, a power or steam operated steam trap is used to discharge the condensate from the heater. Considerable condensation or entrained water is carried with the exhaust steam into the regenerator, which must be discharged from it. As the working pressure carried is usually below atmospheric and as ample head can be obtained for a water seal to discharge under these conditions, this method of relief is used. The overflow of the seal is situated so as to operate either with vacuum or pressure, being able to discharge to the atmosphere with pressures of four or five pounds plus or minus.

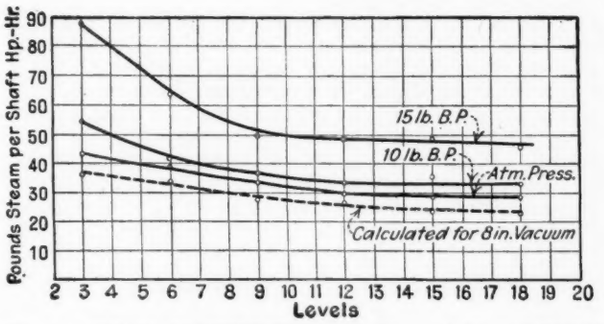


FIG. 3. STEAM CONSUMPTION OF 24 x 60-IN. HOISTING ENGINE AT DIFFERENT BACK PRESSURES

Provision is made to supply live steam to supplement the exhaust through two reducing valves in series. The reducing valve on the high-pressure side is of the ordinary type and reduces down to fifteen pounds. The other valve is of the diaphragm type, operated by auxiliary pressure introduced by means of a special control mechanism.

Steam from the regenerator is delivered to the buildings to be heated with a drop in pressure not to exceed two pounds at times of greatest demand and about one pound during average winter conditions. A two-pipe system is used. In the buildings the drainage of mains and return lines is in the direction of the flow, thus eliminating water hammer. Sylphon traps are used on all radiators, direct and indirect, and all headers and drips. The air and condensation are collected into and returned by a 3-in. line, the end of which is submerged, forming a water seal that is located in the boiler house. At a point about twenty feet above the overflow of this water seal is located an air-separating tank, from which the air and noncondensable vapors are drawn from the system by a vacuum pump, requiring for its operation about 1½ horsepower.

The pressure carried on the regenerator, being also the back pressure on the hoist, varies from 8 to 10 in. vacuum to one-half pound above the atmosphere; the colder the weather the lower is the average of the range maintained. The return-line vacuum is usually constant at about 18 in., making a working pressure available, therefore, of about eight pounds, which is more than sufficient in almost any emergency.

Of the several plants, the coal consumption before and after installing regenerators, the tons of rock hoisted during the same periods and the radiation involved in each plant are given in the accompanying table. There was a slight reduction in the tons hoisted in most plants during the year following the regenerator installations, but this did not affect the coal consumption materially, for in most cases

RESULTS OBTAINED BY INSTALLATION OF REGENERATORS

Shaft	Coal Consumption				Rock Hoisted				Radiation Involved Sq.Ft.
	Before Regenerator Installation		After Regenerator Installation		Before Regenerator Installation		After Regenerator Installation		
	Years	Tons	Years	Tons	Years	Tons	Years	Tons	
Nos. 2 and 3, Champion	1916	5,340	1917	2,076	1916	290,000	1917	240,000	18,000+
No. 4, Champion	1916	4,296	1917	2,256	1916	335,000	1917	292,000	11,000+
No. 2 Tramountain	1918	4,235	1919	2,908	1918	303,650	1919	295,510	7,000+
Nos. 4, 5, and 4 Baltic	1918	11,410	1919	9,766	1918	373,150	1919	349,970	11,000+
		25,281		17,006		1,301,800		1,177,480	47,000

Of the several plants, the coal consumption before and after installing regenerators, the tons of rock hoisted during the same periods and the radiation involved in each plant are given in the accompanying table. There was a slight reduction in the tons hoisted in most plants during the year following the regenerator installations, but this did not affect the coal consumption materially, for in most cases

some live steam was used for heating, there not being enough hoisting to supply the need. At Nos. 2 and 3 Champion, the live steam thus used would have been available for additional hoisting, so that only a few more tons of coal could have been used had the same tonnage of rock been hoisted. The results exceeded expectations, and in some instances the installation and remodeling costs were returned by the savings made during the first year's operation. In all cases at least one boiler was shut down, and in some, two were discontinued.

Relative steam requirements of the hoists before and after the regenerators were installed were determined from continuous indicator diagrams taken in a series of tests. The curves in Fig. 3 make a comparison of the steam consumption per shaft horsepower-hour for a 24 x 60-in. engine hoisting a 5-ton loaded skip when operating at various back pressures. The dotted line shows the calculated consumption were the hoist to operate at 8 in. vacuum, which is the back pressure obtainable when regenerators are used; this result has since been verified. The comparison shows why a saving of one-third of the coal is possible.

Figuring Generator Requirements

To show the method of figuring regenerator requirements, the large plants at Champion (Nos. 2 and 3) have been taken as an example. The radiation to be heated at that time totaled 16,000 sq.ft. Allowing ¾ lb. of steam per square foot for coldest weather, the maximum requirements per hour would be 5,300 lb. and for average winter conditions, with a consumption of ¼ lb. per square foot, 4,000 lb. per hour. In addition to this about 600 lb. is required for heating boiler-feed water, and 10 per cent must be allowed for condensation in transmission, requiring, therefore, approximately 5,000 lb. per hour as the average consumption. The hoisting averaged about fifty-five trips during the eight-hour working period, and was from an average depth of 1,600 ft. The time to make the complete hoisting cycle was 110 sec. The idle period, or time during which no steam flows, was 6.9 min. and under actual conditions at that time did not often exceed 12 minutes.

Exhaust from two hoists is used to supply the regenerator. The average steam consumption of these engines per cycle when hoisting from the sixteenth level (this being the average hoisting depth) was found to be 275 lb., making available an average of 3,800 lb. per hour. To this must be added steam from the auxiliary cylinders of the hoists, which amounted to an additional 12 per cent, or about 400 lb.; also 200 lb. from boiler-feed pumps, making a total available of 4,400 lb. per hour.

For a twelve-minute idling period of both hoists, a steam storage of 1,200 lb. was required to provide for the heating requirements during the coldest weather. The amount of water required to store that amount of steam, when using a pressure range on the regenerator from 8 in. vacuum to zero, can be determined as follows:

Latent heat of steam at 4 in. of vacuum, or average of the working range = 975 B.t.u.; 975 × 1,200 lb. steam = 1,170,000 B.t.u. required.

Temperature of water in the presence of steam at atmospheric pressure, 212 deg.; temperature of water at 8 in. of vacuum, 197.7 deg.; difference 14.3 deg.

Pounds of water required to store this heat = 1,170,000 ÷ 14.3 = 81,818 lb.

Weight of water at the above temperature equals 60 lb. per cubic foot; amount of water required, 81,818 ÷ 60 = 1,363 cu.ft. The storage capacity of the regenerator installed, 1,190 cubic feet.

Hydro-electric power is beginning to be utilized by the tin and copper mines of Bolivia. The Guggenheims, of New York, have acquired rights to three tin mines in the department of La Paz, consisting of more than 4,000 hectares. Water and power rights to some six streams in the vicinity of the mines have been secured, and a hydro-electric power plant is to be built, but the site has not been decided on. The installation of a smelting plant run by electricity is under consideration. The company plans to found a town below the mines and construct an electric tramway to it.

The Diesel Engine and the Automobile

By Charles Day, M. Sc.

In a paper read before the Institution of Automobile Engineers, as reported in *The Practical Engineer*, Charles Day stated that as regards the application of the Diesel engine to automobile work the method of introducing the fuel into the cylinders and the conditions of combustion were the limiting factors at present.

In regard to the spraying of the fuel into the cylinder, it will be readily appreciated that time is a factor in forcing oil through an atomizer, and that as the viscosity of the oil increases the time required to force the oil through will increase, or the atomizer design must be changed. With free-flowing oil and with an air pressure of 1,000 lb. per sq.in., the author was of the opinion that atomizers of prevailing design could, with suitable oils, be arranged to deal with speeds up to 500 or 600 revolutions per minute. At 600 revolutions the time during which the fuel is sprayed into the cylinder is approximately 1/200 of a second. For higher speeds atomizer modifications will need to be developed.

The character of the fuel oil is a factor in the permissible engine speed, both from the point of atomization and that of combustion. Viscous oils are more difficult to atomize than the free-flowing oils and cannot be put through a atomizer so quickly.

Again, the combustion of heavy oils is not so rapid as that of refined oils such as paraffin or petrol, and if the engine speed is so high as not to allow sufficient time for the combustion of the fuels, difficulty will arise from sticky pistons, smoking exhaust, etc. From this it would seem that high-speed engines may need refined oils, in which event one of the great advantages of the Diesel engine will disappear.

Another factor that must be kept in mind for automobile work is range in speed. In the Diesel engine ignition depends on the temperature of the air at the end of the compression, but if the speed is reduced very much it may happen that the cooling effect on the slowly compressed air is enough to prevent the temperature from reaching the ignition point. There is thus a limiting factor to the slowness of speed, and the range of speed permissible with the Diesel engine is not so great as with petrol engines, in which the ignition is obtained by a spark.

Before Diesel engines are likely to be applied extensively to automobile work, development along the lines indicated will be necessary, so that higher rotative speeds can be adopted and reduction of space and weight thus secured.

The Electrical Review, London, states that the Italian Government has already granted concessions for the exploitation of water power of more than 2,000,000 hp., of which 1,500,000 hp. has already been developed. The fact that the concessions have not been utilized to their full extent is attributable to the high cost of construction and the lack of material. Italy's requirements in electric energy are very large; 500,000 hp. will be required for the manufacture of nitrogenous fertilizers and 4,000,000 hp. for the running of blast furnaces and the working up of spelter. Power requirements will be further increased by the electrification of the railways; projects already sanctioned provide for the electrification of 4,000 km. (2,500 miles). The electrification of the entire system would result in the saving of 1,800,000 tons of coal annually, which is equivalent to 800,000,000 or 900,000,000 lire ($160,000,000 or $180,000,000).

The A. A. E. schedule of salaries for engineers in municipal service was unanimously adopted recently by the American Society for Municipal Improvements at the convention of that body in St. Louis. The schedule was prepared by a subcommittee of the Committee of the American Association of Engineers on Salaries of Engineers in Public Service. Samuel C. Hadden, editor of *Municipal and County Engineering*, is chairman of the subcommittee. The schedule contains lists of fair salaries for engineers of various grades in cities of different populations.

Hazards of Power Plant Construction

BEFORE the National Safety Council Congress held recently in Milwaukee, W. H. Mulligan, of the Hydro-Electric Power Commission of Ontario, presented an interesting paper on the "Hazards of Power Plant Construction," omitting reference to accidents that are common to all industries and may be classified under handling tools, handling material, slipping, tripping and falling, stepping on nails, eye injuries, etc.

In all construction work good lighting is essential. The wiring must not be makeshift, but of good material, used and installed under proper supervision. Damp places require the best reinforced portable cords and weatherproof sockets, and it should be the specific duty of some one person to see that all electrical equipment is in first-class condition.

In all building work, ladders are in constant use, and as a rule all types may be found. It should be a rigid requirement that only ladders properly constructed by a competent workman should be allowed. No ladder reinforced longitudinally with metal should have a place in any work in which it will at some time be used for electrical operation. The ladder should be equipped with some form of non-slip footing. For outside use a spiked type has proved most satisfactory, and for the inside, any type that will not damage the floor or allow the ladder to slip on a smooth floor on which there may be oil can be used.

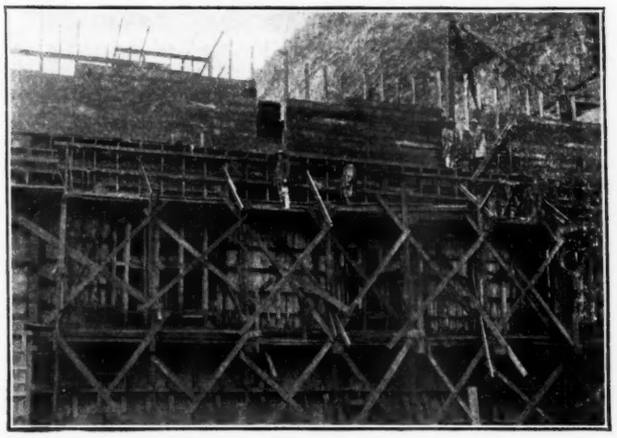


FIG. 1. SUBSTATION SCAFFOLDING WITH NO RAILINGS NOR TOEBOARDS

All scaffolds should be equipped with a railing 42 in. high and a toeboard. To the latter particular attention must be paid, especially where the scaffold passes over equipment that may be alive. Fig. 1 shows scaffolds that are substantially constructed but entirely lacking in safeguards. Neither railings nor toeboards have been provided, and the platform is obstructed with various materials. The conditions shown are exactly what must be guarded against.

Pure air must be supplied to the workmen even if it is necessary to install fans. Drills and hammer heads must be kept dressed, and when holding drills, tongs should be used and goggles worn. Care must be taken that the jaws of wrenches are in first-class condition. No defective tools should be used, as a failure or a slip will result not only in the ordinary hazard which would arise, but an extra hazard imparted should live electrical equipment be present.

If the work is located below a cliff, scaling operations must be carefully and continually carried out, and cranes, hoists, elevators, permanent stairways and ladders should be constructed as soon as possible.

If it is necessary to operate a railway, a proper set of operating rules and signals should be placed in effect and all men who operate the trains should receive the standard eye and ear tests.

All work in a power house or substation that is in operation must be under the direct control of the man who has a definite set of construction rules for his guide. The operator in charge of the station should have the necessary authority to hold up any work which he feels is going to endanger life or apparatus and must work in close conjunction with the man in charge of the construction work.

For the protection and guidance of the workmen danger signs should be installed. A proper sign must display the universal danger emblem accompanied by such wording that the nature and location of the danger is apparent. In these signs the foreign element must be considered and the warning published in different languages. The sign shown in Fig. 2 meets these requirements. It is placed in all bunk houses and at tool wickets. For general electrical use the signals shown in Figs. 3 and 5 are employed. The lined portions indicate bright red as it is used in the signs.

During construction, in order that operation may not be unnecessarily interrupted, certain pieces of apparatus are alive one day and dead the next. To reduce the possibility of a mistake, the tag shown in Fig. 6 was placed in service. The foreman assumes the responsibility for this sign and attaches it to the apparatus which has just been turned over to the operating department, either for temporary or permanent use. He marks the voltage and a safe working distance. All equipment not yet turned over to the operating department or which has been released by them for construction purposes, should have one of these special tags, and when the equipment is so marked, it must be wholly under the control of the construction foreman. Safe working distances as laid down by the Hydro-Electric Power Commission of Ontario for their various operating voltages are as follows: 110,000-volt line or apparatus, 5 ft.; 46,000-volt line or apparatus, 4 ft.;

Wherever you see the above sign it means
DANGER—Keep Away
A tout endroit ou vous verrez cette affiche, elle indique
DANGER—N'approchez pas
Dovunque Voi Vedete Questa Insegna Voul Dire
PERICOLO—State Fouri

FIG. 2. UNIVERSAL DANGER EMBLEM AND PRINTED WARNING

FIG. 3. DANGER SIGNAL FOR GENERAL USE

FIG. 4. UNIVERSAL DANGER EMBLEM

26,000-volt line or apparatus, 3 ft.; 13,000-volt line or apparatus, 2 ft.; 6,600-volt line or apparatus, 2 ft.; 2,200-volt line or apparatus, 2 ft.

These distances are only a minimum and should be considered as such. As much clearance as possible should be obtained in all cases.

For a universal danger emblem the sign shown in Fig. 4 has been of great assistance.

If general work is being carried on in the vicinity of live apparatus, it must be screened in such a way that it will be impossible to make accidental contact. There are times when it may be necessary to work within the foregoing minimum distances. No workman should be allowed to use his own judgment in this matter, but special permission must be obtained for each individual case and then

FIG. 5. HIGH-VOLTAGE DANGER SIGNAL

FIG. 6. DANGER SIGNAL GIVING DISTANCE

granted only when it is impracticable to carry on the work in any other manner. At such a time two men must always be present. When work must be performed above live equipment, a scaffold should be built over the live section so that it will be impossible for falling tools or materials to cause an arc.

In all work of this nature the operating man must not be forgotten when the work for the day has been finished. Aisles should be left reasonably free from obstruction, any gallery rails that have been removed should be replaced or the openings protected, and if any extra-hazardous condition exists which might interfere with operation, it must be pointed out to the operator.

Relative to fire hazard care must be taken to leave no excelsior or packing around the switchroom, as such material is an added risk in case of an oil explosion. Gasoline should be stored in minimum quantities in safety cans. Fire equipment must not be removed nor access to it blocked. An adequate supply of extinguishers should be distributed over the works, in the camps, storehouses and offices.

In a large construction camp it would be impossible to get every man to practice resuscitation, but a certain few men in each group should be so trained, and in the electrical construction gang every man must know and must practice resuscitation.

According to William Clayton, vice president and managing director of the San Diego Electric Railway Company, the San Diego Consolidated Gas and Electric Co. has purchased the power house of the railway company for $1,000,000 and also the heating plant of the United Light, Fuel and Power Company, of San Diego, for $100,000. The sale is now subject to the approval of the State Railroad Commission. The San Diego Consolidated Gas and Electric Co. is to furnish the street-railway company with power to operate its cars.

The New York Chapter of the American Association of Engineers has voted to contribute a sum not to exceed $100 toward the promotion of the bill providing for a national department of public works.

Electrical Engineers Discuss Lightning Protection

On Nov. 12 the American Institute of Electrical Engineers met in Chicago under the joint auspices of the Chicago Section and the Protective Devices Committee of the society, with the electrical section of the Western Society of Engineers participating. In the afternoon the board of directors of the Institute and the various committees held their scheduled meetings and in the evening a reception and informal dinner at the City Club, followed by a technical session on "Lightning Protection" at which four papers were presented.

D. W. Roper's paper on "Studies in Lightning Protection on 4,000-Volt Circuits" was of exceptional interest. The author endeavored to list the several factors that affect lightning-arrester performance and to describe the methods of eliminating these several variables so as to permit the presentation of curves showing the relative merits of the arresters under investigation. The other three papers of the evening were: "Electrostatic Condensers," by V. E. Goodwin; "Lightning Arrester Spark Gaps," by Chester T. Allcutt, and "Life and Performance Tests of O F Lightning Arresters," by N. A. Lougee. The attendance was exceptionally good and the discussion brought out many interesting points on the subject of the evening.

Union Labor and A. A. E. Lock Horns

The Building Trades Council of Newark, N. J., is making an effort to unionize engineers, architects and draftsmen. The council has issued an ultimatum to the effect that after Nov. 1, 1920, union labor, as represented by its members in Newark, would do no work on new buildings or other structures for which the plans were not made by union draftsmen or engineers. The American Association of Engineers, which is vigorously opposing the idea, reports that draftsmen in the architect offices in Newark have been canvassed on the question of union affiliation, and that almost to a man they are opposed to any unionization of draftsmen, engineers or architects. The General Contractors' Association of Newark will continue to use plans made by non-union architects and draftsmen, and James O. Betelle, president of the New Jersey Chapter of the American Institute of Architects, is working in harmony with the A. A. E. on this matter.

Chile has vast hydro-electric resources, which have been but slightly developed, chiefly by German and British capital. The most definite development project in that country at the present time is that provided by a $35,000,000 loan by the Chilean government, $10,000,000 of which has been appropriated for the electrification of the railway from Santiago to Valparaiso, via Casablanca. The electric generating station is to be located on the Aconcagua River, about thirty miles from Llai-Llai. In fact, the Chilean government will electrify all the state railways, and plans are in charge of Senores Rafael Edwards, the electrical consulting engineer for the state railways, and Ricardo Solar, a civil and electrical engineer of prominence. Moreover, an internationally organized company (Anglo-Chileno-Americano) in Valparaiso plans to construct a 10,000-hp. plant for supplying electric lighting and power to that region.

The only time since 1911 that coal has been exploited in Armenia was in 1915, when some 50,000 tons were extracted for the use of the troops in the region of Olti. These coal fields are 27 miles from the town of Olti in the valley of the Kanli-Sou River, in the region of the villages of Bal-Kai, Souzous, Karatash and Gueliat. They were discovered and explored by one Dr. Gadomokin, and the deposits have been estimated at 12,000,000 tons. The nearest railway station to the Olti coal fields is Kars, which is only 76 miles from the Kars-Merdeneck mines.

The Development of Oil Specifications

By W. F. PARISH†

FIVE years ago a prominent builder of Diesel engines, in an attempt to standardize the lubricating oil for his new type of engine, sent to twelve of the most prominent oil manufacturers in the country a full description of the engine with photographs and drawings, asking them to submit a gallon sample of the oil they would recommend. The result was that the best oil men in the country submitted 37 different oils, no two alike, varying all the way from 136 sec. Saybolt Universal viscosity at 100 deg. F. (and 41 sec. at 210 deg. F.) to about 3,500 sec. viscosity at 100 deg. F. (actually 178 sec. at 210 deg. F.). The engine referred to required, for the conditions under which it was to operate, an oil having a viscosity of from 450 sec. at 100 deg. F. for the paraffin oils to 750 sec. at 100 deg. F. for the asphaltic base oils.

The questions for engine builders to consider are: First, Why is there such a wide difference of opinion among oil men as to what is necessary to properly lubricate the same machine?

Difference in Opinion as to Proper Lubricant

The difference in opinion as to the proper lubricant for a certain unit may have a vast effect upon the operation and results obtained from that unit. Taking the Diesel engine example as an instance, using the lightest oil submitted would allow the main bearings to operate at low temperature and would allow a low power consumption. The oil, however, would be entirely too thin for the power cylinders or air-compressor cylinders, and there would be the consequent danger of excessive scoring or wear. On the other hand, it would be impossible to use the heaviest oil recommended in the lubricating system of the engine; and further, this oil would be entirely too heavy for the power cylinders, would form excessive carbon which would prevent the free movement of the rings, would cause scoring of the cylinders and wear, and the same general condition would also prevail in the air-compressor cylinders. This very heavy oil, therefore, would be absolutely unsuited as a lubricant for any part of the engine in question.

Second, What system can be introduced that will make it possible for the engine builder, the oil industry and the users of the machines to co-operate for the purpose of bringing about the desired results?

Theoretically, the engine builder should be able to specify the classification and grade of oil that should be used on his machine; he should pass this information on to the operator who purchased his machine and the latter should be able to buy that particular kind of oil wherever most convenient. This preconceives a universal language in regard to oil that would be perfectly understood; and it also makes necessary the general establishment of some form of specification and nomenclature acceptable to both the oil industry and the manufacturers of engines.

Historical

Oil refiners have always been averse to specifications and attempts made at standardization of petroleum products. This position is easily explained. Specifications or laboratory readings as originally drawn by the refiners were developed for the purpose of allowing standardization of their own production, and the necessary instruments were patented and built by the large refiners for their own use; as these same instruments were not obtainable by the small refiners, several different methods of taking apparently the same reading resulted. This was especially true of the viscosimeter.

The type that is today generally in use was developed by one of the large refiners and for many years could not be purchased or made by the smaller refiners. Many consumers of large quantities of lubricating oil made their own pipettes and other instruments which were not used by the refiners, and while for many years the word "viscosity" has been used, its meaning in definite terms has been obscure, owing to the fact that it was often impossible to tell upon what instrument the test had been made; the temperatures used were not always the same and the method of operation was different. As a result of this disorganization the term conveyed little outside its interpretation by the individual oil companies.

Probably the first outside agencies to make use of refinery instruments were the various states, when it was found necessary to limit the volatile nature of burning oils. Nearly every state had a different instrument or had a different method of using the same instrument, so that for years there has been a controversy regarding the proper method and instruments to use in determining flash and fire tests.

Fifteen years ago practically all the lubricating oils came from the Pennsylvania fields and were, therefore, generally uniform. As a result of using one crude oil, the various refiners put out practically the same oils and regularly marketed brands, such as "25 Gravity Paraffine" or "885 Paraffine Oils," named for the Baumé and specific gravity of the two respective oils, became standard for the jobbing trade; and these oils, which in time were produced by various refiners under a general classification which was entirely the result of trade custom, were uniform to a degree.

First Specifications Issued

Consumers, however, eventually came to the point of issuing specifications. These first specifications called for blends of a certain percentage of some particular local crude with other combinations generally impossible for the majority of refiners to secure or furnish, and it looked as if that specification had been issued on the advice of some one marketer who was manufacturing that particular combination, therefore making certain the fact that he would retain the business.

When the new oil fields were discovered in California, Texas and the Midwest, producing oils that had entirely different physical characteristics from the Pennsylvania crudes, the specifications established and used by various industries in purchasing their supplies very effectively barred the new oils. Combating Pennsylvania specifications was probably the hardest task that fell to the lot of the marketers of the newer oils, and it required constant and expert attention to change this situation. It was necessary to run many comparative tests to prove that oils not meeting the authorized specifications would meet the mechanical needs of the machinery, and in this way it was possible sometimes to have the specifications changed so as to admit the new oils. Many times the revised specifications, when finished, could have read simply "oil," as they were so broadly drawn as to be practically no specification.

On the other hand, specifications not broad enough to allow competition, or that require manufacturers to turn out a special oil when some stock product would meet the requirements, are practically useless.

These conditions from an economic standpoint were undesirable and the general acceptance of specifications as a policy by the industry was discouraged, the refiners generally taking the stand that writing specifications should be left to the discretion of the oil refiner for his own specific use and that the customer should simply ask for a product for a certain purpose, allowing the refiner or marketer to send his experienced operators into the customer's plant to designate which of the oils on his established list would do the best work.

Innumerable instances were also found where specifications, which were used to facilitate purchases, did not cover oils that were entirely suited for the machinery in the plants, and as a result of mechanical troubles other oils would be purchased entirely opposite to the specification,

*Abstract of paper read before the National Gas Engine Association.

†Sinclair Oil Co.

resulting in many heated discussions between the purchasing agents, plant engineers and oil-company representatives.

There is no question but that specifications that were properly drawn and that actually represented lubricants satisfactory for operating conditions would help the refiner and make his work more simple, and they would also be a help to the purchaser, as under such specifications he could be sure of purchasing oils of certain classifications which he had already determined by trial or builders' recommendation were suitable for the machinery in his plant.

There are many points to be taken into consideration in drawing up specifications. They must be simple and readily interpreted by the trade, and they must be broad enough to allow bids on suitable oils from all crudes. Further, they must be so worded as to call for low-, medium- and high-priced oils, according to the work to be done. For instance, oils that are intended for ordinary lubrication and oils for special requirements, such as turbines and internal-combustion engines, might have the same flash and fire, viscosity and cold test and yet the oil for the special work would have been so refined that it would handle the severe conditions; and as a consequence of this special refining the manufacturing cost of this oil would be increased and it therefore would come into the high- or medium-priced classification as compared to the oil for ordinary lubrication.

Government Specifications

That specifications can be so written that they describe the oil required and yet allow wide competition is shown by those of the War Department. When the first specifications were drawn up during the war, it was necessary to have a minimum number of grades and each oil was made to cover as wide a range as possible. Where it was possible to use the more expensive oils for purposes where, ordinarily, cheap oils would be used, this was done; it was considered that the increased cost in using the expensive oil was more than offset by the cost of handling additional brands under war conditions. This was especially true of the specification covering motor oil, which was used as widely as possible in substitution of the numerous cheaper oils for various uses; and as the greatest gallonage was to be used for the motor transport units, the oil necessary for that equipment was considered more or less as standard and used for many purposes. The Navy Department also follows this practice of using the high-class oils for less important lubrication; for instance, turbine oil will probably be used for machine-shop lubrication because it simplifies the storage and makes impossible the danger of getting an ordinary machine-shop oil in the turbines, as one such performance would more than offset a year's savings on purchases of the cheaper oil.

The specifications at present used by the War Department have been drawn up to cover three classes of oils, which will fall under grade or price classification. This is covered practically as follows:

Class A states that the oil is required for general lubrication of engines and machines where a highly refined oil is not required, which would mean that a cheap, red oil of the viscosity mentioned would be suitable.

Class B states that the oil is to be better than Class A oil. This specification also includes an emulsion test which would necessitate a better oil than furnished under Class A.

Class C covers oils suitable for lubrication of air compressors and internal-combustion engines and is also suitable for turbines, dynamos, high-speed engines, forced-feed systems, etc., where a better lubricant than Class B is required. In addition to the tests required under Class A and Class B is included a carbon test which will insure the oil furnished being a highly refined, filtered product, entirely suitable for this class of work.

Under each of these classes the oil is divided into five grades, with the following viscosity range at 100 deg. F. Saybolt Universal: Extra light, 140-160 sec.; light, 175-210 sec.; medium, 275-310 sec.; heavy, 370-410 sec.; extra heavy, 470-520 sec. The flash and fire and cold test range of all three grades are also the same. The refining requirements as expressed in the acidity, emulsion and carbon tests bring these classes of oils into different finished products, which will vary through a considerable range as to operating results secured and as to prices. These specifications are so drawn that they will admit suitable oils made from all crudes, which illustrates the point that this is possible if the necessary attention and knowledge enter into the transaction.

The official machinery for the establishment of methods and instruments in the American Society for Testing Materials, Committee D-2, has already reported upon and adopted many of the main instruments and methods. The Bureau of Standards at Washington should be the natural authority to go to in order to get the proper interpretation and to secure standard samples and readings on uniformly standard instruments, so that any laboratory can check its instruments. The Navy Department and War Department specifications, which have been written with the aid of the petroleum industry and generally accepted by them, can be taken as acceptable in form and nomenclature as a general guide to specification writers. It then remains for the engine manufacturer to select the classification and grade of oil that will best suit the condition of his machinery when new and after it is well worked in, and this had best be done with the assistance of the many able lubrication engineers in the petroleum industry. After this the machines can be marked with the established classification and grade of oil according to army specifications or other standards that may be generally accepted, and this will be the guide the oil manufacturer will gladly use in selling oil to the owner and operator of the machine.

Optimistic Reports Received of Coal Situation

The report of the Geological Survey for the week ended Nov. 6 showed a decrease of 9.4 per cent in the production of soft coal. The total amount of coal mined was 11,355,000 tons; this was 1,063,000 tons less than for the previous week. The reduced output was only natural in view of the occurrence of the two holidays, Election Day and All Saints' Day, but was nevertheless larger than had been expected. It was, in fact, greater than in the corresponding week of any of the last four years. The average daily production was 1,893,000 tons. It is expected that for the week ended Nov. 13 production will be high.

A bulletin issued by the National Coal Association takes the same view and reports noticeable improvement and reduction of shortages throughout the country. It is declared that prices are falling and will continue to drop wherever they are high. This is attributed to the aggressive cooperation of the Interstate Commerce Commission and the railroad executives. Through the priority order issued by the commission during the summer and fall and carried into effect by the railroads, the operators have been able to get the open-top cars needed to transport the volume of coal required to overcome the shortages.

Statements of coal prices received by *Power* in answer to its request indicate that those who have contracts are not suffering greatly from high prices, but that those who must buy in the open market are paying "all the traffic will bear." As an instance, one report gives the price of run-of-mine coal, *at the mine*, as $8; another sets it for the same kind of coal, *delivered*, at $3.85. The latter figure, of course, was for contract purchases.

The consumption of soft coal mined in the United States is divided as follows, according to Messrs. Smith and Tryon in *Coal Review*: 2.1 per cent for generating power at the mines; 28 per cent for railroad fuel; 6 per cent for electric public utilities; 21.9 per cent for coke, bunker coal and exports; 10 per cent for domestic use; 5 per cent for the steel industry, and 27 per cent for the general industrial demand.

The Virginia Ice and Freezing Corporation, of Norfolk, has had such success with two 300-hp. Smith gas producers it is preparing to install three more Smith Type E producers of 300-hp. each. These producers will be used to supply gas to the engines used in this plant and are designed for anthracite coal, being provided with shaking grates and baffle type scrubbers.

New Publications

ELEMENTS OF ENGINEERING THERMODYNAMICS. By Moyer, Calderwood and Potter. Published by John Wiley & Sons, New York City. Cloth; 196 pages; 47 illustrations; 4 tables.

As the authors state in the preface, this volume is an extension of a briefer work by Moyer and Calderwood. Considerable material that is essential in a textbook of thermodynamics has here been added to the original text, increasing the value of the present work to a considerable extent. Although written primarily for engineering students, it should be of benefit to all engineers having a knowledge of calculus.

LESSONS IN ELECTRICITY AND MAGNETISM. By W. S. Franklin and Barry MacNutt. Published by Franklin & Charles, Bethlehem, Pa., 1919. Cloth; 254 pages; 188 illustrations. Price, $2.25.

In this book is presented the theory of electricity and magnetism by making use of things that are found in practice. The material has been arranged to meet the need of a two years' course in elementary physics and is divided into seven chapters with four appendices, namely: Magnetism and the magnetic effect of the electric current; chemical effect of the electric current; heating effect of the electric current; induced electromotive force; electric charge and the condenser; electric field and elementary theory of potential; the atomic theory of electricity; magnetism of iron; elementary theory of alternating current; electrical measurements; corresponding equations of translation motion, rotary motion and electrical motion; and answers to problems. Although this book was written primarily for use as a text, the arrangement and the presentation of the material are such as can be easily mastered by the home student. Numerous problems are given throughout the text, and since the answers are given in an appendix, it greatly enhances the value of the book to those who wish to study the subject of electricity and magnetism outside the environs of the classroom.

Obituary

Arthur M. Waitt, who was a member of the commission which planned the electrification of the New York Central Railroad, died on Nov. 10 at his home in Sharon, Conn. He was born in Boston in 1858, and was graduated from the Massachusetts Institute of Technology with an engineer's degree. Mr. Waitt was with the New York Central for twenty-five years, and was a member of the New York Railroad Club, American Society of Mechanical Engineers, St. Louis Railroad Club and the Hartford Club.

Arthur E. Hauck, president of the Hauck Manufacturing Co., maker of oil-burning appliances, kerosene torches, furnaces and forges, died recently at his home in Brooklyn at the age of forty-one years. Mr. Hauck originally followed the coppersmith's trade in Germany, his native country, and later in Belgium, France and England. At twenty years of age he arrived in this country almost penniless and went to work in the Philadelphia Navy Yards. In 1902, three years later, he established himself in the oil-burning appliance business to which he devoted the remainder of his life.

Personals

George Macnoe is now associated with W. B. Connor, Inc., New York City, engaged in the sale of power-plant equipment.

Ralph K. Rowell has left the position of equipment engineer with the International Motor Corporation to affiliate with a firm the name of which will now be Hubbard, Harris & Rowell, Inc., consulting engineers.

Charles H. Israel, formerly works manager of the National Marine Engine Works for the Foundation Co., has been appointed Eastern representative of the Kingsford Foundry and Machine Works, of Oswego, New York, for the sale of stationary and marine unaflow engines.

M. M. Shaw is now power engineer for the Cooley & Marvin Co. of Boston, Mass. He was formerly engineer with the Perry Barker firm of fuel engineers, Boston.

W. S. Quigley, president of the Quigley Furnace Specialties Co, New York City, has returned from Europe after an extensive trip made in connection with large installations of the Quigley Powdered Coal System in Italy and Belgium.

Business Items

The Manistee Iron Works Co., of Manistee, Michigan, manufacturer of Roturbo centrifugal pumps, vacuum pumps, rotary jet condensers, evaporating equipment for salt, sugar, potash, etc., has opened a Pacific Coast office in the Rialto Building, San Francisco, which will be in charge of L. M. Page, formerly general sales manager. The company expects to open other branches at Los Angeles, Portland and Seattle, which will also be under the supervision of Mr. Page.

Trade Catalogs

The Batterman-Truitt Co., 736-738 West Monroe St. Chicago, has issued a 3 x 6-in. 30-page revised catalog of ventilating equipment, including fans driven by pulley and d.c. or a.c. motors.

"The Technical Products Economist" for November, listing thousands of items of new and used machinery and equipment for sale, is ready for distribution. It contains five sections: Refrigeration, power, pulp and paper, tank, and chemical.

The Milwaukee Electric Crane and Manufacturing Co., Milwaukee, Wis., has ready for distribution an 8 x 11-in. 48-page catalog of electric cranes and hoists, and also of a horizontal boring mill. A great number of pictures show the manufacture, design and use of Milwaukee cranes.

New Construction

PROPOSED WORK

Mass., Charlestown (Boston P. O.)—The Charlestown Gas & Electric Company, 27 Main St., will soon award the contract for a 1 story, 50 x 50 ft. electric substation on Salem St. French & Hubbard, 88 Pearl St., Boston, Archts. and Engrs.

Mass., Provincetown—Andrews, Tower & Lavalle, Archts and Engrs., 274 Main St., are preparing plans for a fish plant on Cape Cod St. About $500,000. Owner's name withheld.

Mass., South Hadley—Mt. Holyoke College plans to build a new science building and an addition to the library. About $500,000. Archt. not selected. M. E. Wooley, Pres.

Conn., Hartford—The Aetna Life Insurance Co., 650 Main St., plans to build an office building on Trumbull St. Over $2,500,000. Archt. not announced.

Conn., Middletown—The Middlesex Hospital, 28 Crescent St., will soon award the contract for a 3 story, 40 x 108 ft. hospital addition including a steam heating system. About $250,000. Buck & Sheldon, Inc., 60 Prospect St., Hartford, Archts.

N. Y., Brooklyn—The Dept. of Educ., 500 Park Ave., New York City, is having plans prepared for a 5 story, 125 x 197 ft. school including a steam heating system on Sanford St. near De Kalb Ave., here. About $750,000. C. B. J. Snyder, 28th floor, Municipal Bldg., New York City, Archt. and Engr.

N. Y., New York—The Auditorium Association, c/o Slee & Bryson, Archts. and Engrs., 154 Montague St., Brooklyn, will receive bids until Dec. 1 for a 4 story 50 x 75 ft. club and office building at 250 West 25th St., here. About $250,000. Noted June 15.

N. Y., New York—The Bd. Educ. received bids for the installation of heating and ventilating apparatus in Public School 74 from Miller & Brady, Inc., 210 East 38th St., at $6,000; J. Dames Co., 1996 Nostrand Ave., Brooklyn, $6 278; D. J. Rice, 405 Lexington Ave. here, $7.223. In Public School 81 from L. Ruetzle Co., Inc., $16,422; D J. Rice, 405 Lexington Ave., $17.182; Miller & Brady, 210 East 38th St., $17,339.

N. Y., New York (Bronx Boro.)—The New York Institution for Education of the Blind, 9th Ave. and 33d St., plans to build seven 2½ story institutional buildings including a steam heating system, on Bronx and Pelham Pakways Bronxwood Ave and Williamsbridge Rd. McKim, Mead & White, 101 Park Ave., Archts. and Engrs.

N. Y., Rochester—The Bd. Educ. is having plans prepared for a 2 story, 180 x 200 ft public school and two 2 story, 300 x 325 ft. junior high schools at $1 500,000 each. E. S. Gordon, 300 Sibley Block, Archt.

N. Y., Troy—The United American Iron & Steel Co., Van Buren St., is in the market for one double drum, steam power hoisting engine of ten ton capacity. F. Samuels, Jr., Gen. Mgr.

N. J., Maurer—The Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa., is having plans prepared for machinery and manufacturing buildings and a power house, here. About $1,000,000. Lockwood-Green Co., 101 Park Ave., New York City, Archts. and Engrs.

Pa., Philadelphia—St. Agnes' Hospital, Broad and Mifflin Sts., is having plans prepared for a 5 story, 84 x 161 ft. nurses' home including a steam heating system. F. R. Watson, 1211 Walnut St., Archt.

D. C., Washington—The General Pur. Officer of the Panama Canal, here, will receive bids until Nov. 26 for furnishing one 60-kva., 25-cycle, 3-phase, 2,200-2,080-volt primary, 230-volt secondary, transformer, delta-connected, oil cooled and insulated; indoor type for power service.

Va., Minnesota—The Bd. Educ. plans to build a 2 story, 150 x 250 ft. grade school including a steam heating system. About $300,000. Archt. and Engr. not selected.

W. Va., Clarksburg—Dr. W. P. Goff and Maj. G. D. Goff plan to build an addition to a hotel. About $500,000. Archt. not selected.

W. Va., Huntington—The International Nickel Co., 43 Exchange Pl., New York City, will build a rolling mill plant here including a steam heating system, here. About $3,000,000.

N. C., Greensboro—The Piedmont Ice & Coal Co. plans to build an ice plant. About $75,000.

Ala., Birmingham—The city is having plans prepared for a 3 story, 150 x 300 ft. high school on 7th Ave. About $600,000. D. O. Whilldin, Title Guaranty Bldg., Archt.

La., New Orleans—The Marine Iron Wks., 1008-1014 Magazine St., plans to build a 1 and 2 story machine, boiler and blacksmith shop. About $75,000. J. de Tarnowsky, 602 Canal Bank Annex, Structural Engr.

Ky., Covington—The city voted on $250,000 bonds for the purchase of a 10,000,000 gal. pumping unit and boilers. R. Russel, Comr. of Pub. Property. Noted Oct. 12.

Ky., Walton—The city has authorized an issue of $10,000 bonds for a municipal electric plant on Main St.

O., Ashtabula—The Pierce, Butler & Pierce Co., 282 James St., Syracuse, N. Y., plans to build a plant here. About $1,000,000.

O., Cleveland—The Taylor Stores Co. will receive bids until Dec. 1 for a 17 story, 67 x 189 ft. department store and office building. About $1,250,000. D. H. Burnham & Co., 209 South La Salle St., Archt.

O., Columbus—The Bd. Educ. is having preliminary plans prepared for two 2 story, 110 x 200 ft. schools, one on Avondale Ave. and the other on Douglas Ave. About $265,000 each. Riebel & Sons, New First Nat'l Bank Bldg., Archts.

O., Dayton—The Dayton Power & Light Co., 4th and Jefferson Sts., plans to issue $1,000,000 bonds for the purchase of generators, turbines, transmission material, transformers, etc., for the purpose of increasing the output of the Miller's Ford plant.

O., Sandusky — The Sandusky Cement Co., Engineers' Bldg., Cleveland, plans to build a 1 story, 40 x 52 ft. addition to its power house, here. About $25,000. W. B. Newberry, Engineers' Bldg., Cleveland, Engr.

O., Willoughby—The Thor Tire & Rubber Co., c/o R. C. Gary, 802 Society for Savings Bldg., Cleveland, plans to build a 1 and 3 story, 60 x 250 ft. factory and power plant here. About $300,000.

O., Youngstown—The Reserve Iron & Steel Co. plans to build and equip two blast furnaces and a puddling plant. About $1,000,000.

Ind., Hammond—The Masonic League will receive bids until Dec. 20 for a 1 story, 100 x 100 ft. temple including a steam heating system. About $250,000. R. G. Schmidt & Co., 154 West Randolph St., Archt.

Mich., Detroit—The Detroit Packing Co., 40 Bushey St., is having plans prepared for the first unit of a 5 story packing plant. Plans will also be prepared for separate power plant. About $1,000,000. Packers' Architectural & Engr. Co., Manhattan Bldg., Chicago, Ill., Archt. and Engr.

Mich., Detroit—The Orling Bros., Heidelberg and Elmwood Aves., are having plans prepared for a 3 story, 60 x 100 ft. meat products factory including a 100-hp. boiler for washed air heating system. Power motors and refrigerating equipment will be installed in same. About $200,000. Louis Kamper, 751 Book Bldg., Archt.

Mich., Detroit—Pollmar, Ropes, Archts. and Engrs., 45 State St., are preparing plans for a 1 and 2 story 100 x 160 ft. factory. Power motors will be installed in same About $75,000. Owner's name withheld.

Mich., Detroit—Thos. Barlum & Sons, Cadillac Sq., are having plans prepared for a 1 story, 100 x 100 ft. market building. Refrigerating equipment will be installed in same. About $75,000. Rogers, Bonnah & Chaffee, 528 Farwell Bldg., Archts.

Ill., Chicago—The Masonic League, c/o Hyde & Brown, Archts., 8 South Dearborn St., will soon award the contract for the superstructure of a 4 story, 125 x 200 ft. temple including a steam heating system at 6107 College Grove. About $750,000.

Ill., Chicago—G. E. Spry, c/o A. Alshuler, 28 East Jackson Ave., is receiving bids for a 7 story, 80 x 140 ft. office building including a steam heating system at Morgan and Van Buren Sts.

Ill., Chicago—J. Stroh, Detroit, Mich., is receiving bids for an 18 story, 80 x 100 ft. office building, including a steam heating system at 14-20 Adams St., here. About $1,200,000. Gaiver & Dinkelberg, 80 East Jackson St., Archts.

Wis., Fort Atkinson—H. H. Smith, City Clk., is receiving bids for a 6 ft. water gas generator set, meter purifiers, air blowers, etc. for gas plant.

Wis., Merrill—The Secy. of the Bd. Educ. will receive bids until Dec. 15 for a 117 x 140 ft. grade school and a 75 x 120 ft. addition to high school, including a steam heating and mechanical ventilating systems. About $260,000. Parkinson & Dockendorff, Linker Bldg., La Crosse, Archts. and Engrs.

Wis., Milwaukee—The Milwaukee Electric Ry. & Lt. Co., Public Service Bldg., will soon award the contract for a 2 story, 20 x 30 ft. substation on Marshall St. About $10,000. R. Pinkley, c/o owner, Archt.

Minn., Owatonna—Toltz, King & Day, Consulting Engrs., 1410 Pioneer Bldg., St. Paul, are preparing plans for a municipal electric light, power, steam heating and gas plant, here. About $475,000.

Minn., St. Paul—The city voted to issue $3,000,000 bonds for enlargements to water plant including a pumping station, etc. Oscar Claussen, City Engr.

Kan., Montezuma—The City plans to build a 20 x 35 ft., 15-kw. gas plant including a 25-hp. gas engine. About $15,000.

S. D., Mitchell—Frank McGovern, City Aud., will receive new bids for a 1 story, 182 x 300 ft. corn palace auditorium including a steam heating system. About $300,00. C. W. & G. L. Rapp, 1200 State Lake Bldg., Chicago, Ill., Archts. Former bids rejected. Noted Aug. 10.

Tex., Corsicanna—The Navarro Manufacturing Company is in the market for a 30 to 35 hp. upright steam boiler. Second hand preferred.

Tex., Dallas—The Federated Jewish Charities, 1814 Ashland Ave., are raising funds for a hospital. About $1,000,000.

Tex., Dallas—The City and County of Dallas are having plans prepared for a hospital including an extension to the present steam heating plant. About $450,000. Herbert M. Greene, North Texas Bldg., Archt.

Tex., Lubbock—The West Texas Sanatarium Assn. had plans prepared for a 4 story hospital building including a boiler room, etc. About $110,000. Henry T. Phelps, Gunter Bldg., San Antonio, Archt.

Tex., Mineral Wells—The city voted on $200,000 bonds for installing pumping equipment at Lake Mineral Wells and building pipe line from there to supply city with water.

Tex., Port Arthur—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., plans to build a 14 x 39 ft. radio building here.

Tex., Waxahachie—The city plans an election to vote on $100,000 bonds for a municipal electric light system.

Okla., Tulsa—The Masonic League, 518 South Main St., will soon award the contract for a 6 story, 100 x 140 ft. temple including a steam heating system. About $650,000. R. G. Schmidt & Co., 154 West Randolph St., Hammond, Ind., Archt.

Idaho, Idaho Falls—The Howard Pulp & Paper Co. will soon receive bids for a news print factory and an 18,000-hp. power plant. About $4,000,000. Thomas L. Tomlines, City Bank Bldg., Syracuse, N. Y., Engr.

Cal., San Diego—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until Dec. 1 for refrigerating equipment here.

Cal., Victorville—The Victor Valley Irrigation District is having surveys made for an irrigation system including a hydro-electric plant, booster pumping plant, 3 reservoirs, etc. About $7,000,000. F. C. Finkle, I. W. Hellman Bldg., Los Angeles, Consulting Engr.

Ont., London — The Young Men's Christian Assn., c/o E. T. Jenkens, 429 Wellington St., plans to build a new Y. M. C. A. building including a steam heating system. About $300,000.

Ont., Toronto—The Crouse Hinds Co. of Canada, Labatt Ave., Harvey Hubbell and the Hubbell Mack Machine Screw Co. plan to build a 3 story factory including a vacuum steam heating system on Coxwell Ave. for the manufacture of electric light fixtures. About $500,000.

South America, Peru, Lima—A. Grana had plans prepared for a cotton mill including a steam heating system. About $500,000. Lockwood-Green Co., 101 Park Ave., New York City, Archts. and Engrs.

CONTRACTS AWARDED

Me., Auburn—The Young Men's Christian Assn., 2 West 45th St., New York City, has awarded the contract for a Y. M. C. A. building including a steam heating system, to F. A. Rumery, Inc., 21 Portland St., Portland, at $250,000.

Conn., Bridgeport—The City Engr., c/o Bd. Sewer Comnrs., has awarded the contract for a pumping station to be known as the Island Brook Station, to the Bridgeport Constr. Co., 983 Broad St., at $30,000.

N. Y., New York—The New York Curb Market Assn., 25 Broad St., has awarded the contract for an exchange building including a steam heating system on Trinity Pl. to Thompson-Starrett Co., 49 Wall St., at $750,000. Noted Jan. 27.

N. Y., Utica—The Utica Steam & Mohawk Valley Cotton Mills, 801 State St., has awarded the contract for a boiler plant extension to Stone & Webster, 120 Bway., New York City, at $350,000.

Md., Annapolis—The city has awarded the contract for furnishing and installing one 150-hp. boiler in the municipal pumping station to H. E. Crook Co., Inc., 28 Light St., Baltimore, at $7,825.

Md., Baltimore—The United States Fidelity & Guaranty Co., Calvert & Redmond Sts., has awarded the contract for a 3 story office building including a steam heating system at Calvert and Mercer Sts. to Geo. Dose Engr. Co., 43 West 27th St., New York City, at $500,000. Noted Oct. 12.

Md., Baltimore—The City Council has awarded the contract for a 76 x 271 ft., 50 x 241 ft. school including a steam heating system at 76 Latrobe Park to the Standard Constr. Co., 1713 Sansom St., Philadelphia Pa., at $495,000.

Va., Norfolk—The Beth El Congregation, c/o Herts & Robinson, Archts., 331 Madison Ave., New York City, has awarded the contract for a synagogue including a steam heating system, here, to E. W. Winter Co., Inc., 115 Bway., New York City, at $250,000. Noted Feb. 9.

O., Cleveland—The Babies' & Children's Hospital Assn., c/o Garfield, 915 National City Bldg., has awarded the contract for a 9 story, 60 x 150 ft. hospital at 11020 Euclid Ave. to Crowell & Little Constr. Co., 1951 East 57th St., at $500,000. A steam power plant will be installed in same. Noted Sept. 14.

O., Cleveland Heights (Warrensville P. O.)—The City Ice Delivery Co., H. D. Norval, Pres., East 20th St. and Euclid Ave., Cleveland, has awarded the contract for a 2 story, 66 x 84 ft. tank and engine room on Cedar Ave. and Lee Road here, to Younger & Farmer, 1670 Crawford Rd., Cleveland, at $75,000.

O., Elyria—The Bd. Educ., c/o S. S. Rockwood, has awarded the contract for a 2 story, 98 x 200 ft. school including a steam heating system at Gulf Rd. and Ohio St., to Drummond-Miller Co., 4500 Euclid Ave., Cleveland, at $300,000.

Mich., Detroit—The Bd. Educ., 5 Bway., has awarded contracts for addition to Abbott School inciluding a steam heating system to A. W. Hutche, Ford Bldg., $217,213; Marxhausen School on Warren Ave. to F. N. Cooper, Penobscot Bldg., $190,000 and the Majeska School on Trombley St. to Brayton Engr. Co., 907 Kresge Bldg., $195,733.

Ill., Chicago—Joseph Klicha, West 20th St. and California Ave., has awarded the contract for several buildings including a 1 story, 18 x 38 engine house, a 1 story, 32 x 47 ft. boiler house, etc., to Stellwager & Co., 1583 Cicbourne Ave., at $100,000.

Ill., Granite City—The School Bd. has awarded the contract for a 2 story, 125 x 234 ft. high school including a steam heating system on Alton Highway to R. B. Higgins Bldg. and Constr. Co., 1143 Childress Ave., St. Louis, Mo., at $320,000.

Wis., Carrollville—The U. S. Glue Co. has awarded the contract for a 30 x 40 ft. boiler house to P. Riesens Sons, 1018 Humboldt Ave., Milwaukee. Bids will soon be received for two 150-hp. boilers.

Wis., Fond du Lac—The Forest Ave. Hotel, c/o J. P. Walsh, Vice-Pres., 170 Forest Ave., has awarded the contract for a 4 story, 90 x 120 ft. hotel to L. Schroeder, Main Street, at $250,000. A steam heating system will be installed in same.

Wis., Wausau—The Wisconsin Valley Electric Co., 206 3rd St., will build a water power electric plant and dam. About $600,000. L. A. DeGuere Grand Rapids, Mich., Engr. Work will be done by day labor.

Iowa, Fort Dodge—The Bd. Educ., c/o Paul Gustafson, Secy., has awarded the contract for a 3 story, 190 x 260 ft. high school including a steam heating system, to Madsen & Peterson, 646 Builders' Exchange, Minneapolis, Minn., at $645,300.

S. D., Sioux Falls—Woodbury County has awarded the contract for engine, generators, switchboard, motors and oil tanks for gravel pit to Fairbanks-Morse Co., 900 South Wabash Ave., Chicago, Ill., at $20,000.

Kan., Portes—J. E. Kissel, City Clk., has awarded the contract for waterworks improvements including a 40,000 gal. water tower, 5-hp. motor, new well, etc., to C. H. Everett, Hutchinson, at $25,590. Noted Oct. 26.

Neb., Sidney—The city has awarded the contract for power house equipment including a 450-hp. Ball engine and a Westinghouse generator to the Mine Smelter & Supply Co., 17th and Blake Sts., Denver, Col., at $18,000. Noted Oct. 12.

Tex., Dallas—The Southwestern Forwarding Co., 1301-9 Broom St., has awarded the contract for a 1 story, 120 x 534 ft. warehouse to B. E. Howard, Harwood and Sante Fe Sts., at $150,000. Overhead monorail conveyors, electrically driven stacker, etc. will be installed in same.

Col., Denver—The city has awarded the contract for the installation of a steam heating system in the proposed junior high school, to Joseph Pfeiffer, 1140 California St., at $63,688. Noted Nov. 16.